POWER

Vol. 43 NEW YORK, JUNE 27, 1916 No. 26

On the Dedication of New "Tech"

By Charles H. Bromley

HUMAN PROGRESS is a story of developed ideas.

That Inscrutable Force that Herbert Spencer liked so much to write about seems to have willed that a certain few among the multitudes are to conceive epoch-making thoughts, while to others it is given to unfold what the master minds have formulated.

Man strives for the alleviation of human ills and calls the achievement civilization.

It is through industry chiefly that his dreams come true. Science is the only enduring bedrock upon which industry can build, and industry is the truest, because the most useful, expression of science.

No longer does the academician shut himself in his laboratory and, like Faust, invoke the spirits for more fuel for his consuming brain. No more do artisans scoff at the theorist and hide from one another the secrets of their trades. Each realizes that cooperating, their efforts more quickly become stable achievements.

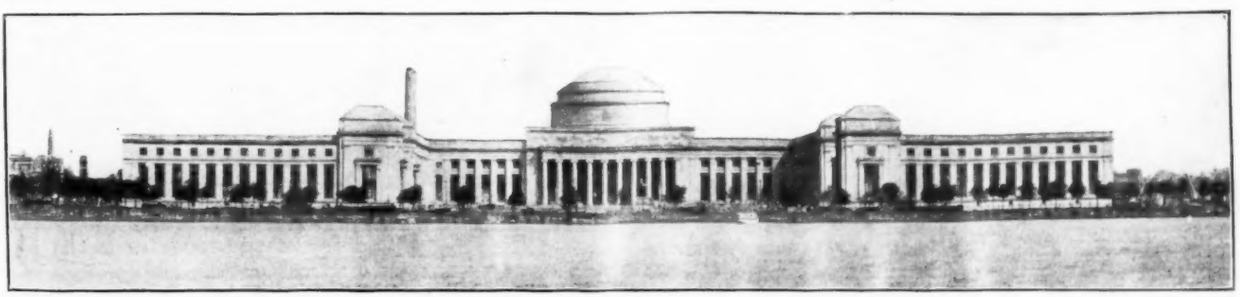
A new era has come.

It remained for William Barton Rogers, founder of the Massachusetts Institute of Technology, to apply the thought that young and potential America needed, and would more and more continue to need, the use of scientific principles in industry. That was fifty years ago. When "Tech" celebrates its centenary, people will appreciate even more fully than now that Rogers had the right idea.

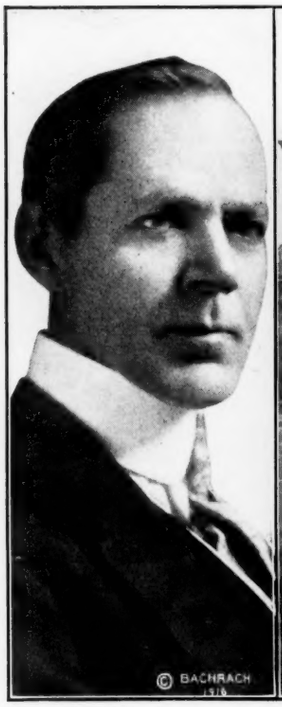
The engineer creates what the scientist conceives—by directing the artisan's hands. The three are the Trinity of Civilization.

"Tech's" achievements throughout half a century have been felt in the four corners of the earth. It is the sincere wish of everybody that in the academic atmosphere of Cambridge she will not lose the force, simplicity and practicability that has brought her fame. Certainly this should not happen, for while the new "Tech" is stirringly magnificent in classic architecture, its laboratories are planned to be most useful to the ends which they serve.

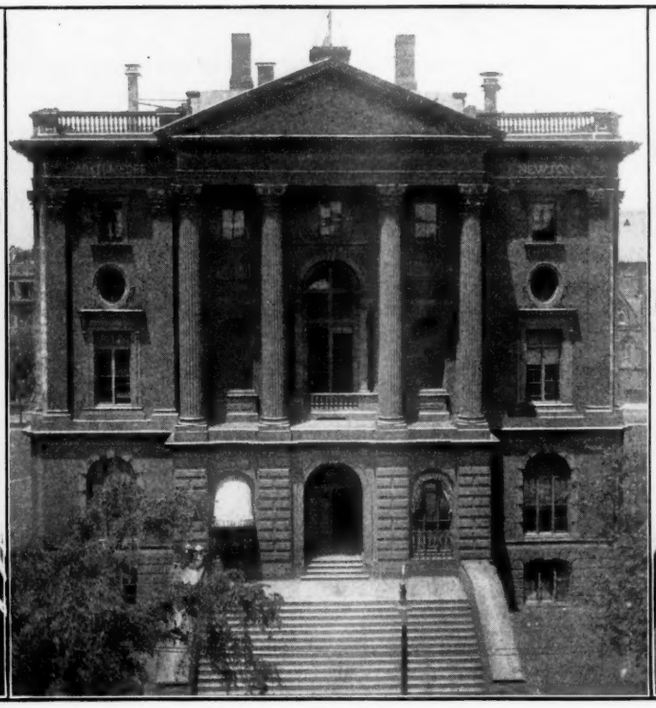
The magnitude of "Tech" is but a condition—the policies that produced it should remain a living creed.



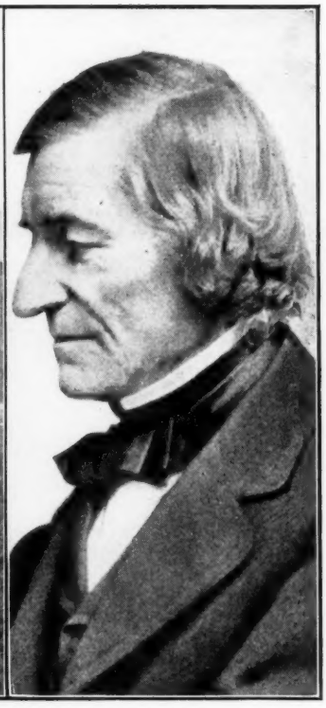
The Dedication of the New Massa



RICHARD C. MacLAURIN,
President



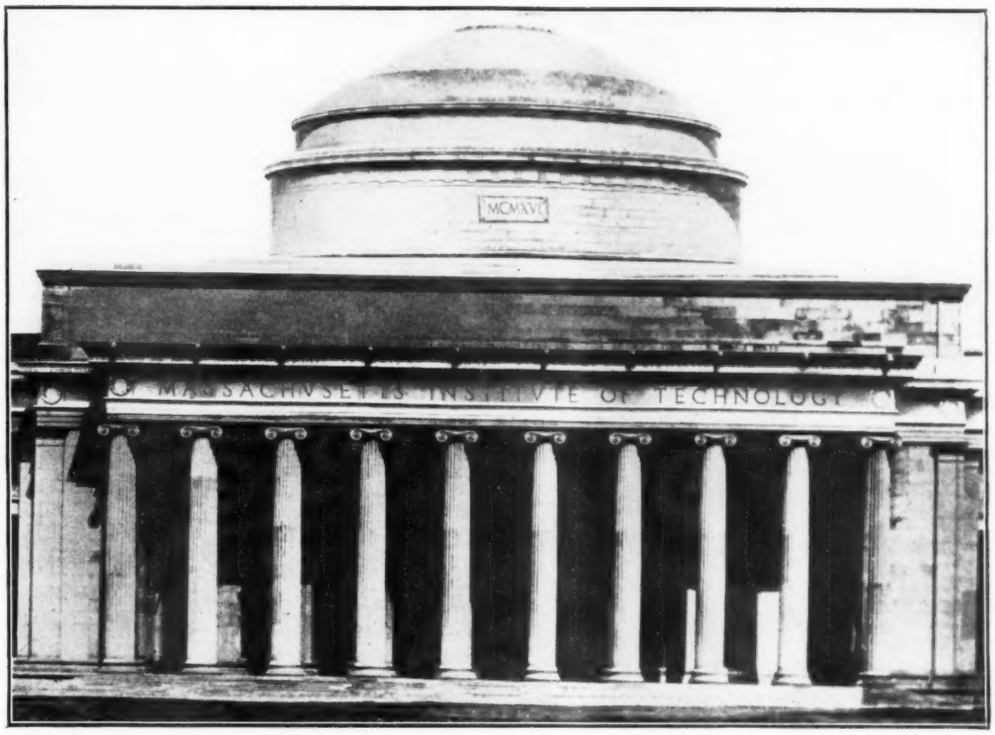
OLD ROGERS BUILDING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY



WILLIAM BARTON ROGERS,
Founder

NEW BUILDINGS OF THE MASSACHUSETTS INSTITUTE

chusetts Institute of Technology



LOOKING AT THE DOME FROM THE GREAT ESPLANADE

OF TECHNOLOGY AS SEEN FROM HARVARD BRIDGE

"Tech" Dedication Celebration

SYNOPSIS—Review of the celebration of the golden jubilee and the dedicatory exercises of the Massachusetts Institute of Technology.

The historical Commonwealth of Massachusetts is proud of the Massachusetts Institute of Technology. The governor, the senior senator from that state and the mayor of Boston proclaimed so during the golden jubilee and dedicatory exercises held in Boston and Cambridge, June 12, 13 and 14. And so did eminent men throughout the country. Why should they not? Nursed to vigor by its founder, William Barton Rogers, only fifty years ago, it stands today the greatest technical educational institution of its kind. The photographs on the preceding two pages indicate the progress.

"Fifty Years of Technology" Exhibit

The program said the celebration would begin Monday, June 12. But it really began Saturday night in the Technology Club, New York. The 300 alumni and ladies who attended also enjoyed the trip to Boston on the steamship "Bunker Hill," arriving Monday morning, escorted by several fast submarine chasers and private yachts. Wireless telegraphy and wireless telephony were features of the trip. The first of the formal exercises began Monday with a "good-by to Rogers" address by James P. Monroe, '82. After class luncheons, the cornerstone of Walker Memorial, a monument to Dr. Walker, late president of "Tech," was laid. The downpours of the afternoon spoiled most of the marine and aëroplane evolutions in the Charles River Basin, but swelled the attendance at the "Fifty Years of Technology" exhibit in the mechanical wing of the new buildings. Here were shown apparatus and photographs of advances, chiefly in the industrial and scientific arts. The water-power section was the most striking and is described elsewhere. The first aëroplane to fly—that used by Wilbur and Orville Wright at Kitty Hawk in 1903—was exhibited. A dinner to Orville Wright was given Monday evening at the Engineers' Club, many notable scientists and engineers attending.

Tuesday the alumni and friends, numbering about 2,500, went to Nantasket Beach. 'Twas a day of stunts and jollification.

The masque and pageant held in the Great Court at New Tech, Tuesday evening, was the most spectacular feature of the week. It was written, arranged and staged under the direction of Prof. Ralph Cram. There were more than 500 performers, mostly Tech students; about 20,000 spectators witnessed the event. The charter and seal of the Institute were brought across the Charles River by members of the faculty and corporation in a Venetian barge, the "Bucentaur." The Masque of Power was then performed.

A steam curtain disclosed the Time Spirit surrounded by the six elements, Earth, Air, Fire, Water, Steam and Electricity, and their manifestations, mingling in an intricate dance representing Chaos. As the elements take their thrones, one becomes aware of Primitive Man in their midst bowed in uncomprehending fear and adoration of them; this awe presently grows to the first feeling of religion, the worship of fire, in the midst of which Prometheus seizes fire from the altar and gives it to man. A torch dance celebrates this first conquest of Nature.

Next, Primitive Man in larger numbers attempts the assault on the thrones of the remaining elements, but is beaten off and driven back, until there comes to his help Will and Wisdom, leading the massed forces of Civilized Man of all ages, who sweep forward irresistibly, conquering the elements and seating their own leaders, all great names in science, on the empty thrones.

Civilized Man in triumph at his victory over Nature, breaks out into an arrogant pæan of self-praise, to which the Time Spirit dances. But the triumph is premature, for at once there bursts in upon them the destructive elements of civilization, Greed, Vainglory, Selfishness and War, who, mounted and armed, gallop among the hosts, inciting them to battle, till all the masses of civilization are involved in wild war, accentuated by a pyrrhic dance.

From the river-bank sounds a solemn hymn, to the music of which moves forward Alma Mater with the Seven Liberal Arts. Righteousness, Will and Wisdom welcome her; the Time Spirit leads her to her high throne at the upper end of the court. The masque ended in a glare of fireworks put off from the river bank.

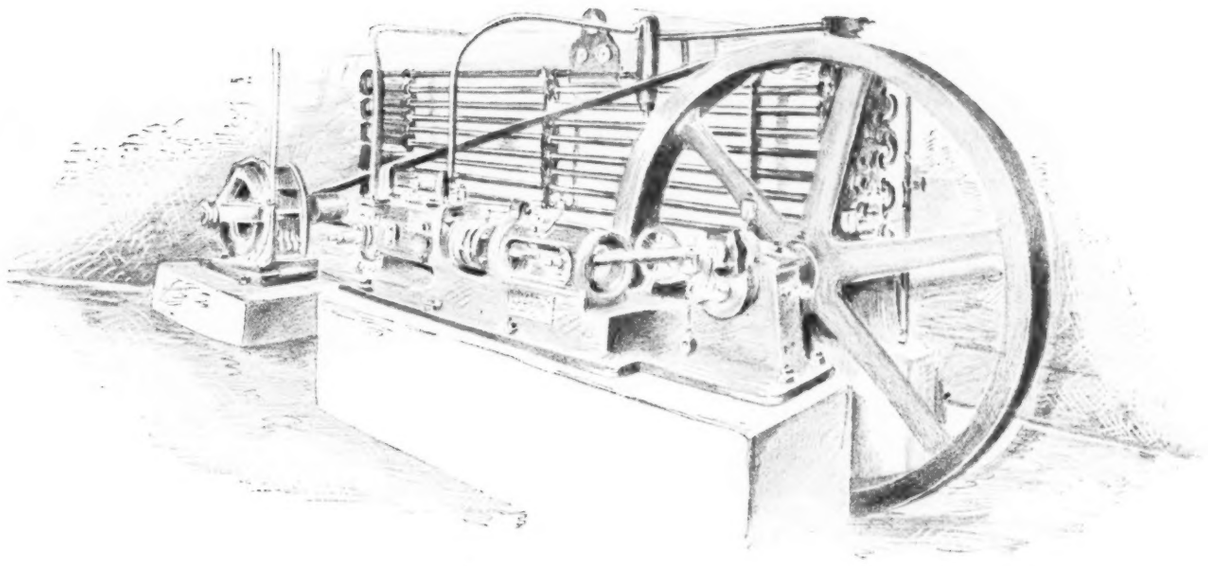
Wednesday morning the class of 1916 graduated amid stirring scenes in Huntington Hall, Rogers Building, where 360 degrees were given. The dedicatory exercises, the most notable of the week, were held Wednesday afternoon. Representatives of various colleges and societies were present, also municipal, state and national dignitaries. Senator Henry Cabot Lodge gave the address of the day after the dedicatory formalities by President MacLaurin of the Institute.

Remarkable Telephone Demonstration

The enthusiasm of 1,500 diners and observers at the banquet at Symphony Hall, Wednesday evening, was deafening and unbounded. The greatest transcontinental telephony demonstration yet arranged was given. Thirty-five alumni and guests in the thirty-five following cities were listening in to speeches at the banquet in Boston: Akron, Atlanta, Boston, Birmingham, Buffalo, Butte, Chicago, Cincinnati, Cleveland, Dayton, Detroit, Duluth, Harrisburg, Indianapolis, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Rochester, St. Louis, Salt Lake City, San Francisco, Seattle, Schenectady, Spokane, Syracuse, Urbana, Washington.

The speakers were J. J. Carty, Toastmaster Charles A. Stone, of Stone & Webster; Dr. MacLaurin, president of "Tech."; Dr. Michael I. Pupin, inventor of the loading coil which made long-distance telephony possible; Dr. Alexander Graham Bell, inventor of the telephone; Dr. H. S. Pritchett, president Carnegie Foundation for the Advancement of Teaching.

Gifts announced at the banquet were: P. S. du Pont, $500,000; T. Coleman du Pont, $100,000; Direne du Pont, $100,000; Lamon du Pont, $100,000; Charles Hayden, $100,000; Charles A. Stone, $50,000; Edward D. Adams, $50,000; "Mr. Smith," on the basis of $5 for $3 given by others, $1,666,666.66; from alumni, $521,000; for chemistry from an anonymous donor, $300,000; for mining from another unnamed donor, $50,000; total, $3,537,666.66.



Operating the Carbon-Dioxide Refrigerating Machine

By F. T. Flenniken

SYNOPSIS—The points to observe while the system is being installed, charged and operated, also how to know the symptoms of troubles of such systems.

In principle the carbonic system of refrigeration is similar to the ammonia wet-gas compression system. The cycle of operation is identical; high-pressure gas leaving the compressor is conducted to condensers, which may be of the double-pipe, atmospheric or submerged type. Here the gas is liquefied and passes out through a liquid receiver and liquid line to the expansion valve. At this point the pressure is reduced to the expanding (evaporating) or suction pressure and the liquid boils and absorbs heat in its passage through the expansion coils. It is necessary to bring back a saturated gas to the compressor to absorb part of the heat of compression, and a good rule to follow is to keep the discharge line at a little better than blood heat—just hot enough so it will not burn the hand when grasped. This temperature is of course controlled by regulating the expansion valve.

As the pressures in a CO_2 system are high, care must be exercised in making joints, and a good grade of extra-heavy iron pipe should be used for the entire gas system. The type of joint shown in Fig. 1 is generally used and, when properly made, is satisfactory. Pipe is screwed clear through the flange so that it projects beyond the face; the end of the pipe is then faced off flush with the face of the flange. The flange should then be screwed down about one-eighth turn, which leaves the pipe protruding slightly beyond the face of the flange. The joint is made on the end of the pipe, and pressure does not get to the threads. A fiber ring is the most satisfactory gasket to use, though a soft copper ring gives good results. Care should be taken to draw up the joints evenly at all four points, and it should be followed up occasionally during the first few weeks' operation. Pipes are generally bent instead of using ell fittings, and it is of advantage to use full lengths of pipe wherever possible, to minimize the number of joints. When pumping up air pressure to test for leaks on a new system, care should be taken not to allow the compressor to overheat. If the temperature in the pipes should reach the flashpoint of the lubricating oil, an explosion might result. Injecting part of a drum of CO_2 into the system while testing will remove this danger, as CO_2 will not support combustion.

The joints should be gone over with soapsuds until all leaks are located and stopped, after which the air can be blown out of the system and a drum of CO_2 connected for charging.

Start water on the condensers and see that the force-feed oil pump for the stuffing-box and cylinder lubrication is working properly. The machine can now be started and gas allowed to flow into the system. After pressure on the high side reaches the temperature of the condenser water (see table), the expansion valve should be adjusted to regulate the pressure on the expansion coils. As rooms or brine tanks are naturally warm, a high back pressure, 30 to 35 atmospheres (450 to 525 lb.), should be carried at first to avoid overheating the compressor, and this can be reduced gradually as the brine or the room temperatures fall. In charging large systems it is sometimes necessary to stop the machine two or three times to allow it to cool.

In operating a CO_2 plant under normal conditions, the condenser pressure should be carried 15 deg. F. higher than the temperature of the injection water (see table). For instance, if the injection water is 70 deg. F., the pressure in atmospheres on the condenser will be 73 (1,095 lb.) when the plant is fully charged and any drop of this pressure, unless caused by a change of the condenser water or the setting of the expansion valve, would indicate a leak in the system.

In general practice a sufficient quantity of water is allowed to flow through the condenser to get a 10- to 15-deg. rise between the injection water and the discharge water. Leaks should be carefully watched for during the first few days' operation. Soapsuds may be painted on the joints; a lighted candle held around a joint will be instantly extinguished by even a small CO_2 leak. An ounce of oil of peppermint may be injected into the system and circulated around with the gas; a leak can then be located by the odor of the peppermint.

After operating a new plant about one week, the scale trap on the suction line should be cleaned. Shut all return valves on the expansion coils, run the compressor a few minutes until the low-pressure gage drops to zero; then the trap may be opened, the strainer removed and cleaned. As there is always considerable dirt and scale in a new system, it is important to clean this trap after first starting; after the first cleaning, once a year will be sufficient.

The oil trap should be blown out daily and the oil filtered. It may be used over again if desired.

If difficulty is experienced in getting proper results from a CO_2 system, it may be due to one of the following reasons:

1. Shortage of gas in the system. Keep the condenser pressure equivalent to 15 deg. F. higher than the temperature of the injection water, and if the pressure is below this point, add gas to build it up. If the pressure keeps gradually dropping, it is certain that there are leaks in the system, and these should be found and corrected.

2. Water in gas. Occasionally a small quantity of water is found in the gas drums, and this will cause trouble in the system by clogging the expansion valves and the compressor valves. Turn the drum upside down and open the valve slightly; if water is present, it will come out first. Manufacturers of carbonic gas are now taking pains to make a dry gas for refrigerating use, and they should be informed that gas is desired for use in a refrigerating machine, when CO_2 is ordered.

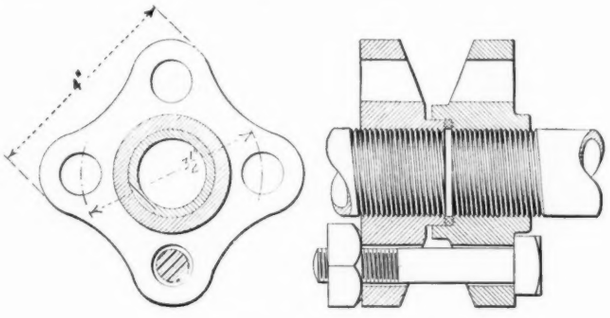
Detecting Leaky Suction Valves

3. Leaking compressor valves. Valves sometimes become pitted by small particles of scale or dirt in a new system, and occasionally one valve will stick. A leaky or sticking valve at one end can be detected by the uneven vibrations of the hands on gages. Feel the caps on the discharge valves, and the hottest is the one that is leaking. A leaky suction valve can be detected by listening carefully with the ear close to the cap. The gas can be heard hissing through the leaky valve on the discharge stroke. When the valves are removed for inspection, see that both valve fibers have an even impression; if one is lighter than the other, add paper washers until they equalize. If the valve is pitted badly, it should be ground.

4. Worn or defective rod or piston packing. The leading manufacturers of CO_2 compressors now use an excellent type of cast-iron ring on the pistons, and these require no attention beyond an occasional inspection, say about once a year. The older machines, however, and some of foreign make use cup leathers on the pistons, and these should be renewed about once every six months.

When the machine shows a decreased capacity and all other conditions are normal, the piston packing should be examined and new leathers applied if necessary. The rod packing should be renewed about once a year, unless on examination it appears to be in good condition. Instances have been known where a set of ordinary rod packing has lasted several years. A set consists of four leathers held in brass keepers and several rings of good spiral packing in the outer box. The leathers are sealed with oil under pressure, which is supplied by an eccentric-driven pump. The outer box of spiral packing holds the oil pressure alone, and any leakage at the front gland will be oil, not gas. It is customary to keep a very slight drip at the front gland.

5. Dirty condenser tubes. Where dirty water is used, the condenser tubes will become lined or covered with mud or soft scale and prevent a free transmission of



PIPE JOINT FOR CO_2 SYSTEM

heat from the gas to the circulating water. When this condition exists the head pressure will be unusually high and the liquid-line temperature will be much higher than that of the injection water. Coils or tubes should be cleaned with a wire brush.

Any good ice-machine lubricating oil with a low congealing point will be found satisfactory for use with a CO_2 machine. As CO_2 has no affinity for oil, the latter does not mingle with the charge, and after the system is clean, oil will be drawn from the trap clear and unchanged. The carbonic system is economical in the use of oil.

CORRESPONDING TEMPERATURES AND PRESSURES OF SATURATED CARBONIC ANHYDRIDE (CO_2)

Temperature, Deg. F.	Pressure, Atmospheres	Pressure, Lb.	Temperature, Deg. F.	Pressure, Atmospheres	Pressure, Lb.
—15	16	252.2	50	46.5	683.55
—10	18	264.6	55	49.5	727.65
— 5	20	294.0	60	52.8	776.16
0	22.2	326.34	65	57	837.9
5	24	352.8	70	61	896.7
10	26.3	386.61	75	65	955.5
15	28.2	414.54	80	69	1,014.3
20	30	441.0	85	73	1,073.1
25	32.5	477.5	90	77	1,131.9
30	34.3	504.21	95	82	1,205.4
35	37.2	546.84	100	86.2	1,267.14
40	40	588.0	105	91.5	1,345.05
45	43.5	639.45	110	96.8	1,422.96

To the refrigerating engineer who has never operated a CO_2 plant, an agreeable experience is in store. These machines, as built by the leading manufacturers, are so safe that a deliberate attempt to do damage with them would result in failure. If the entire charge should blow out in an average engine room, no discomfort would be experienced by the occupants; CO_2 is neutral and harmless to all metals, and will not injure foodstuffs. It is also a positive fire extinguisher. When it is desired to open the system at any point, the work can be started and finished promptly without running to the door every little while for fresh air as is so frequently necessary in plants using ammonia.

The cost of liquid CO_2 in drums is $5 to $6 per 100 lb., while anhydrous ammonia costs $25 to $30. As a rule more CO_2 is lost through leakage than ammonia, considering plants of equal capacity, because CO_2 being odorless, a slight leak is more likely to be overlooked. This condition is offset, however, by the fact that a charge of ammonia, under the usual conditions will decompose to some extent and form noncondensable gases which must be removed occasionally by purging, while CO_2 is so staple a compound that it cannot decompose in the system and purging is never required.

The CO_2 cylinder being only one-fifth the size of the ammonia cylinder on machines of equal capacity, the total clearance volume can be kept very small, and as the ratio of expansion is only about three to one, high compressor efficiency is obtained and the loss from reëxpanded gases reduced to the minimum.

Theoretically, the critical temperature of CO_2 is 90 deg. F., but this does not follow in practice. The writer personally installed a 60-ton CO_2 compressor in southern Texas, where the injection water was 90 deg. F., and owing to an insufficient supply, the discharge ran on an average of 110 deg. F., but no difficulty was experienced in getting rated capacity from the machine.

For low-temperature work the CO_2 machine can reach points impossible with any other system; one machine installed in a chemical works maintains a temperature of 80 deg. below zero F. It is also especially suitable for air-cooling purposes in theaters, banquet halls, restaurants, etc., as the direct-expansion system of air coolers can be used, thus avoiding the complicated system of brine coolers, tanks and pumps necessary with any apparatus using a poisonous or odorous gas as a refrigerant. Then too, there is no fire hazard with CO_2.

Engine-Room Lubrication

By George A. Townsend

SYNOPSIS—This article treats of such subjects as relate to the operation and maintenance costs of machinery when lubricated by different methods.

Experiments have shown that the absolute, or total, bearing friction is very nearly the same whether the bearing supports a light or heavy load, so long as the journal is flooded with oil. The immensely heavy rotating member of a vertical turbine does not exert any greater force tending to rotate its step-bearing than would a short unloaded piece of shaft rotated in the bearing, as long as a fluid friction is maintained. A change takes place, however, if the fluid lubrication is not maintained and the metals come in contact owing to scanty lubrication. The resistance of dry friction is in direct proportion to the load. The resistance of fluid friction is directly proportional to the area of the rubbing surface.

Authorities state that the oil bath represents the most perfect lubrication possible and the limit beyond which friction cannot be reduced by lubrication, and that experiments show that with speeds of from 100 to 200 ft. per min., by properly proportioning the bearing surface to the load, it is possible to reduce the coefficient of friction to as low as $^1/_{1000}$. A coefficient of $^1/_{1500}$ is easily attainable, and probably is frequently attained, in ordinary engine bearings in which the direction of the force is rapidly alternating and the oil given an opportunity to get between the surfaces, while the duration of the force in one direction is not sufficient to allow time for the oil film to be squeezed out.

The journal friction of an engine using hand-fed lubrication is variable, ranging ordinarily from 5 to 7½ per cent. of the indicated horsepower developed. The friction of the same machines using stream-feed lubrication would be from ⅙ to $^1/_{10}$ of this amount, or a saving of friction amounting to from 4 to 6 per cent.; ordinarily this saving is estimated to be about 5 per cent. The reducing of friction produces a series of economies, every one of which is appreciable. The two conspicuous economies are the saving of fuel and in maintenance.

The saving of fuel is always a large item whenever stream oil feed is used and where the fuel is anything else than a waste product. A minimum and a maximum case are presented, showing the savings possible in each. A case of minimum economy would be a small Corliss engine of 250 hp. consuming only 20 lb. of steam per horsepower, running 300 days a year, 10 hours each day, with a fuel costing $1.25 per ton and with an evaporation of 8 lb. of water per pound of coal. The fuel cost covers all expenses incurred in the purchase, handling and burning of the fuel, disposal of ashes and maintenance of such equipment as would be required to burn the fuel and make steam. By adding these various items together, it would ordinarily make a total fully 25c. a ton more than the fuel cost. The minimum case shows a yearly saving in the cost of fuel burning, based on 4 per cent. reduction in friction, as follows: 250 hp. × 20 lb. steam × 10 hr. × 300 days × ⅛ lb. coal × $\frac{\$1.25 \times 4 \text{ per cent.}}{2{,}000} = \$46.87$.

A system that can effect the savings noted would cost approximately $200, and the fuel-burning savings alone would pay 23½ per cent. on the total investment. This case is one which would show as little return on the investment as is likely to be found; the engine is given as one running with good steam economy, the boilers give a high efficiency, fuel cost is low, the running time is short and the smallest percentage of saving in friction is used. Notwithstanding all these conditions, a single saving is shown to be ample to pay a liberal return on the investment.

Another case—one that would show a large return on this fuel cost item is as follows:

Four engines totaling 4,000 hp. average 60,000 hp.-hr. per day; steam consumption, 25 lb. per hp.-hr. running 365 days per year; fuel cost $3 per ton and an evaporation of 7 lb. of water per pound of coal, and a frictional saving of 6 per cent. 60,000 hp.-hr. × 25 lb. steam × 365 days × $^1/_7$ lb. coal × $\frac{\$3 \times 6 \text{ per cent.}}{2{,}000}$

= $7,039.28. A complete installed system, including oil guards and otherwise equipped to effect this saving would cost approximately $2,000. It may not seem possible that there are plants where $2,000 invested will save $7,000 a year, but such exist. Assume the saving to be but 3 per cent., it is over a 100 per cent. investment. Even though two of the items are but half the amount mentioned, the saving in fuel alone will pay for the system in about one year's time.

Ample stream feed will reduce friction to $\frac{1}{10}$ that of scant lubrication and will prolong the life of the bearings and wearing parts to ten times what it would be with scant or hand feed. As an example, a large engine equipped with stream feed, which was to replace another, could not be turned over until it was connected up to take the load. It is common practice to run an engine for at least twenty hours to wear it down to a bearing, and to reset the keys before putting on the load. The engine in question was started off with its load, and after running 260 hr. an opportunity was afforded to inspect the crankpin bearings. The tool marks were still visible over practically the entire bearing, showing that less wear had taken place in 260 hr. with stream feed than is usual in the first 20 hr. with scant drop feed.

Waste of Lubricating Oil

That oil is wasted goes without saying; if it were not, no new oil would be required. Some waste can be avoided and some is impossible to prevent. The loss that it does not pay to try to reduce is extremely small. One of the greatest wastes, one that can be almost classed as a wearing-out loss, is that caused by the destructive distillation in the bearing. With scant lubrication the journal touches in spots, and although the mean temperature of the bearing may seem to be low, the temperature at the contact points is high enough to cause distillation. Whenever an odor is noticeable destructive distillation is taking place. The distillation losses where stream feed is used can exist only where fluid lubrication cannot be maintained, and if the main bearings, crosshead, crosshead pin, crankpin and eccentrics are supplied with stream feed and given fluid support, there will be no measurable amount of distillation.

There is another loss that is difficult at times to eliminate, and that is the loss due to wastage. Oil that gets onto the base or on the floor to be wiped up with waste or is in any way diverted from the return drip flow which conducts the oil back for re-use is a waste—a loss just as apparent as to loosen the bunghole of the barrel and let the oil run away. This loss can be eliminated, but the cost and difficulties attending perfect accomplishment are not justified from a commercial standpoint. There is a limit which those familiar with this work strive to reach and beyond which it is not worth while.

The oil wastage measured in gallons per month on an engine should not be greater than 2 per cent. of the horsepower on small units of 100 hp., and not more than 1 per cent. on large units of 2,000 and 3,000. In other words a 100-hp. engine should not waste over 2 gal. a month and a 2,000-hp. engine not over 20 gal. per month.

Where the responsibility for using oil rests on more than one person, the oil losses become conspicuous in hand oil feeding. A large plant, having about twenty engines all on a large central system, has been able to cut the oil bills one-half, by installing a stream-feed oil system, replacing hand oilers.

The installation of a system in a single engine plant may not result in a material saving in the amount of oil used, and unless the engine is properly guarded, more oil is almost certain to be used. In one case a 250-hp. engine used only 15 gal. of oil per month and it was necessary to place the oil guards in proper condition to reduce the consumption below this amount. They now receive the many savings without loss. This elimination of oil loss is always possible, although it may be necessary to invest as much money in oil guards as in the entire filtering system. This, however, is better than to be denied the benefits of stream oil feed.

Grade of Oil To Use

Oil that is fed to a bearing by hand and with the desire of retaining it as long as possible, being lost when it runs off, must be specifically compounded to have these peculiar characteristics, and such oils are high priced. Stream feed does not require such an oil; in fact, an oil of this kind is not as well suited as the ordinary low-price free-flowing pure petroleum oils. Instead of using oil costing 30 to 40c. a gal., better results can be obtained with one costing about half the amount. Even if the same quantity were purchased with the stream-feed system, the oil bills would be reduced one-half. Usually the quantity is also reduced as much as one-half, making the oil cost with stream feed but one-quarter of that for hand feed. The 4,000-hp. plant previously cited, would use per month, with the system, approximately 60 gal. at 16c. per gal., making $9.60 per month, or $115.20 per year. The savings in oil would be approximately $350 per year. The saving in oil alone would pay 17½ per cent. on the total investment, sufficient to make the proposition attractive.

An oiling system that delivers an ample amount of sufficiently clean oil to an engine that is equipped with a reliable system of oil piping and drips is bound to save the labor formerly used for filling cups and handling such drips as may be caught in drip pans.

Concerning the Labor Item

In considering the labor item in connection with oiling systems, it is necessary to take into consideration the fact that the engineer's work is also materially lessened by the use of stream oil feed. He does not have "keying up" to do so often, and the adjusting of bearings becomes so infrequent that it can be largely disregarded as one of his duties. He is almost, if not entirely, relieved of renewing and scraping bearings and all such work. If the wiping of the engine is part of the engineer's work, he will even then have less to do than when he had an oiler and oil was fed by hand.

When it comes to the saving of labor in plants running more than one shift or where there is an oiler and an engineer, there is always a chance to rearrange the duties of each, and unless the men had previously been greatly overworked, some help can be dispensed with. In the 4,000-hp. plant cited, it would be possible to save not less than two oilers, or a total of $1,000 a year—sufficient to pay for the entire installation in two years' time, or a return of 50 per cent. on the investment.

As a demonstration of vibration losses may be cited a plant having a row of high-speed engines that were literally pounding themselves to pieces. Two were "self-splashers" and the remainder hand-fed. There was a constant struggle—tightening bearings to stop the pound, then loosening them to prevent overheating. The high-speed engines were stripped of their splash oil feeders and equipped with stream feed. The lost motion that characterized everything in the plant has disappeared, the men have now both time and inclination to look after the other parts of the plant.

Concrete is porous and will soak up oil like a sponge. Although oil does not disintegrate concrete, it weakens it so much that it becomes unable to withstand certain strains. An engine will not remain in alignment on an oil-soaked foundation.

Oil guards that prevent oil getting on the foundation are good investments even though the oil collected is allowed to run to the sewer. The guards are worth all they cost if for no other purpose than to save the foundations. By saving the foundation, the engine is saved. When a foundation has started to give away, it can be rectified only by raising the engine, cutting away the oil-soaked part, rebuilding it to the top and resetting the engine, being sure to thoroughly clean the resting part of the engine base so that it is dry and free from oil.

In considering oiling systems there is a direct and correct method of determining the relative savings possible, and that is by comparing the amount of filtering surfaces. A small filtering surface handling the same amount of oil in the same length of time as a larger surface does correspondingly effective work. That is, if a system provides 2¾ sq.ft. of surface for each gallon per hour passed through it, then to secure the same amount of service with 2 gal. an hour through the same surface, it would be half as effective.

There is no secret in passing a large quantity of oil through a small amount of filtering surface; either use coarse filtering materials, heat it so hot that everything will run through, or be cleaning filters every day or so.

A commercial oil-clarifying system is one which removes the impurities that cause harm; and the true value of the system is determined by the savings secured in proportion to the investment. There must be a minimum return that will justify an investment, this minimum being determined by the average earning power of all other moneys invested. If a small, poorly equipped system effects a saving of 10 per cent. on the money invested and the business as a whole pays 12 per cent., it indicates more money poorly invested.

Operating Direct-Current Generators in Parallel

By H. G. Gibson

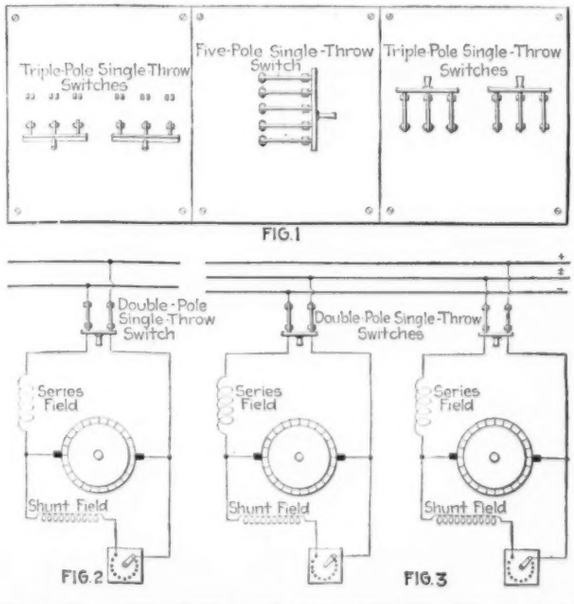
SYNOPSIS—An elementary explanation of the switchboard connections for two two-wire generators in series on a three-wire system, three-wire generators in parallel, and three- and two-wire generators in parallel.

"I wish you would explain to me," said the oiler, at the same time indicating the switchboard, "why the switchboard panel for one generating set has a five-pole switch, while each of the other two generating-set panels has two three-pole switches (see Fig. 1). Why is it necessary for two of the generating sets to have a total of six switch-points each on its respective panel, and the other set to need only five points?"

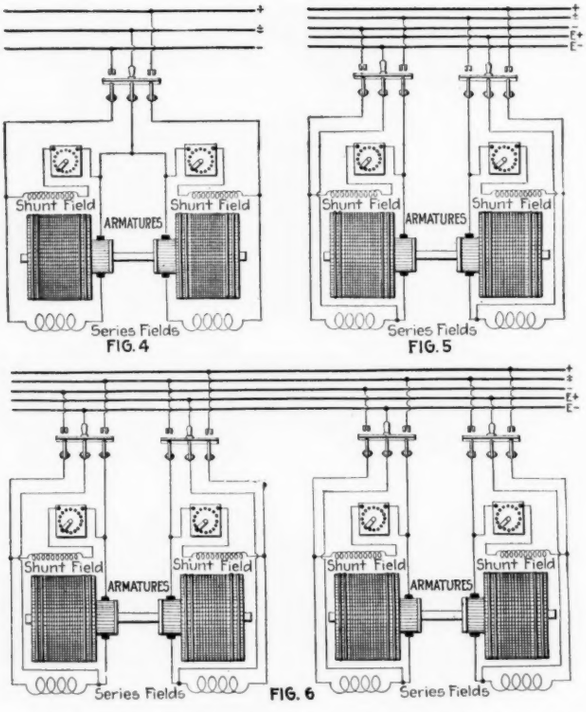
"Well," I replied, "I might tell you that the five-pole switch is connected to the three-wire generator and that the two three-pole switches on each of the other panels are connected to generating sets each of which consists of two 120-volt generators rigidly connected mechanically and in series electrically. That would be true enough, but you would not know much more about it than if I had never said anything, so we'll begin at the other end, so to speak, and work up to the switches gradually.

"To begin with," I continued, reaching for a pencil and piece of paper, "we will start with something that is comparatively simple. Here is a sketch of a compound-wound generator supplying a two-wire circuit (Fig. 2). Obviously one double-pole switch is all we need between the generator and busbars, except the circuit-breaker.

"Consider now Fig. 3, which represents two singly operated generators in series on a three-wire system. We have simply added another busbar to Fig. 2, using a double-pole switch to connect each machine to the bars. With these connections each generator is producing the same voltage, 120, but as they are in series instead of



FIGS. 1 TO 3. SWITCHES AND CONNECTIONS FOR ONE AND FOR TWO TWO-WIRE GENERATORS IN SERIES



FIGS. 4 TO 6. THREE-WIRE CIRCUITS SUPPLIED BY TWO-WIRE GENERATORS IN SERIES

in parallel, the maximum line voltage will be 240, or twice the voltage of one generator.

"Suppose now, we connect the two generators in Fig. 3 together so that they must run in unison. We still have the two double-pole switches and could rigidly connect the handles of these two switches together and operate both at the same time, if desired. The best way, however, would be to displace the two double-pole switches with one three-pole switch, as in Fig. 4.

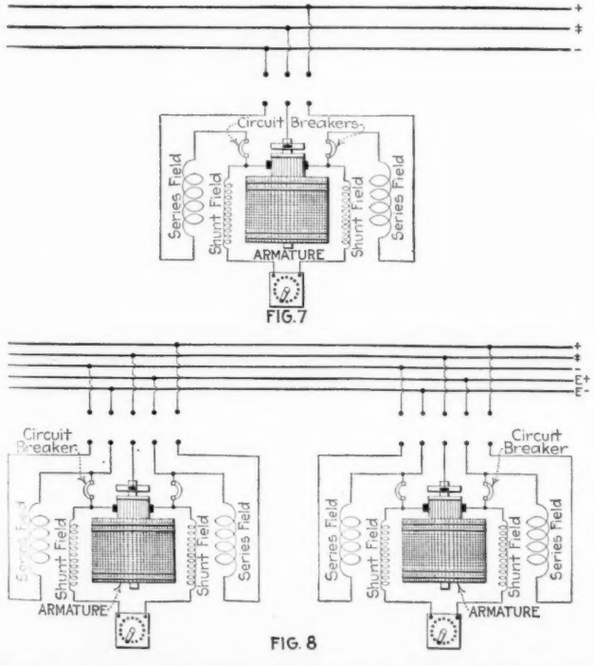
"We now have the simplest three-wire system—two generators rigidly connected running in series. But if it is desired to install another generating set to run in parallel with the first one, two more busbars will be necessary as in Fig. 5; letter these $E+$ and $E-$. In evolving Fig. 5 from Fig. 4, we will put in a line from one side of each generator, the line from one going to $E+$ and from the other to $E-$. But referring to Figs. 3 and 4, it was seen that with two generators rigidly connected, it was possible to use either one three-pole or two double-pole switches. So we will now do away with the two double poles in Fig. 3, and on account of the addition of the equalizing connections, $E+$ and $E-$, will put in two three-pole switches. We now have the condition shown in Fig. 5.

"One can readily see by tracing out the circuits in Fig. 5 that the busbars $E+$ and $E-$ will not be necessary except when it is desired to run two generating sets in parallel. No matter how many generating sets corresponding to Fig. 5 there are in the plant, unless there is more than one of them in operation and connected to the busbars, the equalizers $E+$ and $E-$ will be 'dead.' These busbars simply equalize the current between the generators of two or more sets, when connected in parallel. Therefore, for parallel operation simply extend the busbars and put in another set like the one in Fig. 5 (see Fig. 6).

"It should be plain that in Fig. 6 it would be possible to do away with the two three-pole switches of each generating set and install in their place a single five-pole switch. The object in having two switches in place of one is that each generator may be put on the load separately."

After studying the sketches for a few moments, the oiler looked up and said: "I believe that I have a pretty good understanding of what you have told me, but there are one or two points I should like to have cleared up. You said that the equalizer bars $E+$ and $E-$ were necessary when two sets of machines were running in parallel. Why are they necessary?"

"Equalizer bars are always put in," I replied, "when two or more compound-wound generators are to run in parallel. In installations such as we have here, where two generators are in series on a three-wire system, one of the generators is termed positive (+) and the other negative (—). Since we have more than one of these sets, we must have the equalizer bars. Each set has its + and its — generator. The series fields of all the + generators are connected to the + bar, and the negative bar connects the series fields of the negative generators in the same manner. As I said before, when only one of the generatings sets is in operation, the equalizer bars are 'dead.' But when another set is started up and put on the line in parallel with the first one, these bars form an equalizing medium between the several field coils to which they are connected, and thus stabilize the voltage. For instance, with two sets running, suppose for some reason the speed of one set was to slightly increase and thus increase the voltage slightly. If there were no equalizing connections, this set would take part of the load from the slower-moving machine. This would mean more current through the series-field coils of the faster-moving generator, and this generator would soon be carrying all the load and, in addition, might be running the other generator as a motor. But when equalizer connections are installed as shown, any increase in voltage at the brushes of one machine subjects the fields of the other machines to the same voltage and the field strength of both machines will be increased proportionally. That is, if the voltage and



FIGS. 7 AND 8. SINGLE AND PARALLEL OPERATION OF THREE-WIRE GENERATORS

consequently the load on one machine should increase part of the current of this machine would flow through the series field of the other. This prevents one machine from carrying any more than its share of the load. Therefore, whenever it is desired to run two or more compound-wound dynamos in parallel, it will be necessary to connect their series fields together by equalizer bars.

"Now for the three-wire generator. Fig. 7 shows the busbar arrangement for a single three-wire generator. Note that there are only three bars, and that the switchboard arrangement is similar to that shown in Fig. 4, where there were two generators in series electrically and rigidly connected mechanically. In fact, the three-wire generator is simply one armature generating 240 volts, with a neutral connection which divides this 240 volts into two circuits of 120 volts each.

"In appearance the three-wire generator is very similar to the two-wire. But there is this difference in construction: In the two-wire generator the series-field coils of one machine are all connected in series; in the three-wire generator the series fields are divided into two sections, one on the positive and the other on the negative side. When it is desired to run two three-wire generators in

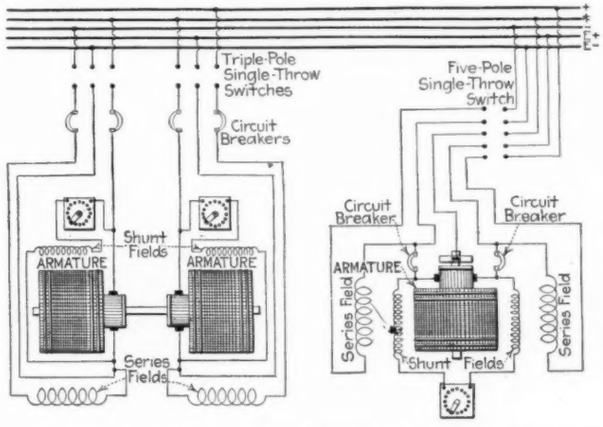


FIG. 9. THREE-WIRE GENERATOR IN PARALLEL WITH TWO TWO-WIRE GENERATORS IN SERIES

parallel, it is necessary to connect the positive series-field coils of one machine in parallel with the corresponding coils of the other through an equalizer, and the negative coils likewise, as in Fig. 8. This will mean two more bars on the board, and a five-pole switch instead of a three-pole on each machine panel. Where there are two or more three-wire generators, just as with two sets of generators (Fig. 6), five busbars on the board are essential.

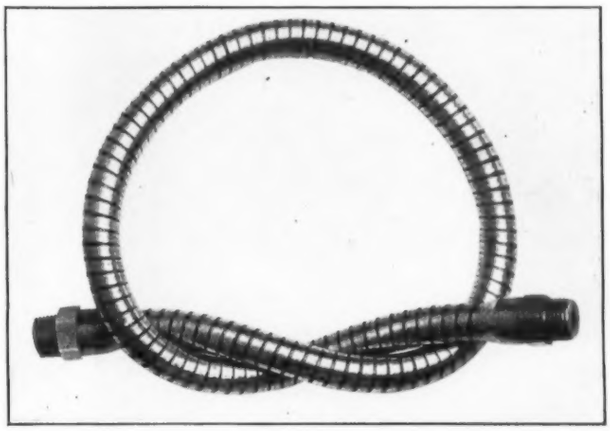
"In our plant there are one three-wire generator and two sets of two two-wire machines in series, all running in parallel. Fig. 9 illustrates the connections of the three-wire unit and one of the other sets, and shows that a three-wire machine may be run in parallel with one or more sets of two machines each, if the positive series fields are all connected in parallel by an equalizer connection, and the negative series fields likewise."

"One thing more," said the oiler, as I indicated my intention to go to another part of the plant. "Why is the circuit-breaker for the three-wire generator placed on the machine frame and not on the switchboard, as the other ones are?"

"There were two reasons for that," I replied. "On account of the very congested condition of the space in the sub-basement in which the cables from the switchboard would have had to run, it was not thought advisable to run any more cables through this space than were absolutely necessary. It is about 20 ft. from the generator frame to the switchboard. If the breaker had been put on the board instead of where it is, it would have been necessary to run two cables from the machine to the board and back. By putting the circuit-breaker on the machine frame, some much-needed space in the sub-basement was saved, as well as the cost of about 80 ft. of cable."

Metallic Flexible Tubing

The use of metallic tubing for general use around the power plant and manufacturing works is growing rapidly and other uses are being found daily. The illustration



METALLIC FLEXIBLE TUBING

shows the product of the Worcester Flexible Tubing Co., Worcester, Mass., along this line. This tubing is made to suit varied requirements.

Automobile Hauls Ash Cars

The photograph shows a 1905 Cadillac automobile used for hauling ash cars at the plant of the American Agricultural Chemical Co., Carteret, N. J. The engineers

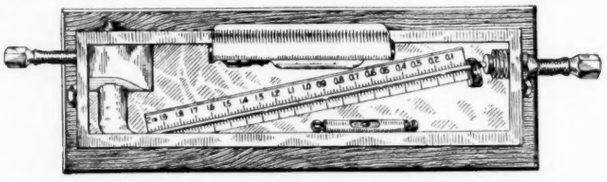
A 1905 MODEL STILL IN SERVICE

found that the cheapest they could get an electric or other locomotive for hauling the cars was $700. The automobile was purchased for $50, and about $50 more fitted it for service on the 2-ft. gage road.

Illuminated Draft Gage

As a general thing a draft gage placed on the side or front of a boiler setting is so located that it is difficult to determine the draft reading.

The illumination of the boiler room is not likely to be changed, and so the Defender Automatic Regulator Co., Sixth and Locust St., St. Louis, Mo., has attached a



DEFENDER ILLUMINATED DRAFT GAGE

light and a suitable shade to its line of draft gages. One of them is shown in the illustration. The shade is made of cast aluminum. The socket is nickel-plated and the globe of the 110-volt tungsten lamp is frosted. The gage is mounted on white-pine backing and is stained a light shade.

Chart Determines Loss Due to Incomplete Combustion

By Hugo F. Hutzel

In ordinary practice the percentages of carbon dioxide, oxygen and carbon monoxide found in the stack gases are merely relative terms. That is, it may be known that one analysis is better than another, that an analysis with no CO is better than one with CO, but usually no attempt is made to ascertain the loss in per cent. due to the percentage of CO shown in the analysis. Not because of any arduous method of determining this loss is it neglected, but because the process is cumbersome.

To facilitate the method of ascertaining this loss, the writer has made the accompanying chart, whereby it may be determined directly.

The chart is based upon the well-known formula,

$$P = C\,\frac{(14{,}540 - 4{,}380)\,CO}{(CO_2 + CO)\,H}$$

in which

C = Proportional part of carbon in the coal;

CO_2 = Percentage by volume of carbon dioxide in the flue gases;

CO = Percentage by volume of carbon monoxide in the flue gases;

H = Calorific value of one pound of coal as fired expressed in B.t.u.

The constants 14,540 and 4,380 represent respectively the B.t.u. liberated when one pound of carbon is burned to CO_2 and CO.

It will be observed from the chart, that the loss due to incomplete combustion can be read in B.t.u. per pound of carbon or coal burned, or directly in per cent.

The use of the chart may be easily understood by following the example given on it.

Nox-Aer-Leek Plastic Cement

One of the sources of heat losses in the boiler room is a cracked boiler setting or air infiltering to the furnace through the porous composition of the bricks. A number of means have been adopted to prevent this infiltration of air, among them being the plastic cement known as "Nox-Aer-Leek," made by the Barrett Manufacturing Co., 10 South La Salle St., Chicago, Ill.

This cement is composed of elastic bitumen fused with nondrying oils and asbestos fiber. It is applied by troweling it upon the exterior of the boiler setting. As it adheres firmly, does not dry out and become hard, the brickwork is made air- and moisture-proof. The cement is about the consistency of fresh putty and is applied with a thickness of approximately ⅛ in.

Pipes and Tubes are made of a great variety of materials, the most common being iron, steel, copper, brass, lead and tin. In recent years two or more metals have successfully been mechanically combined as a lining or covering for special purposes, aside from galvanizing, tinning or plating by the hot process or by electrically depositing one metal upon another.

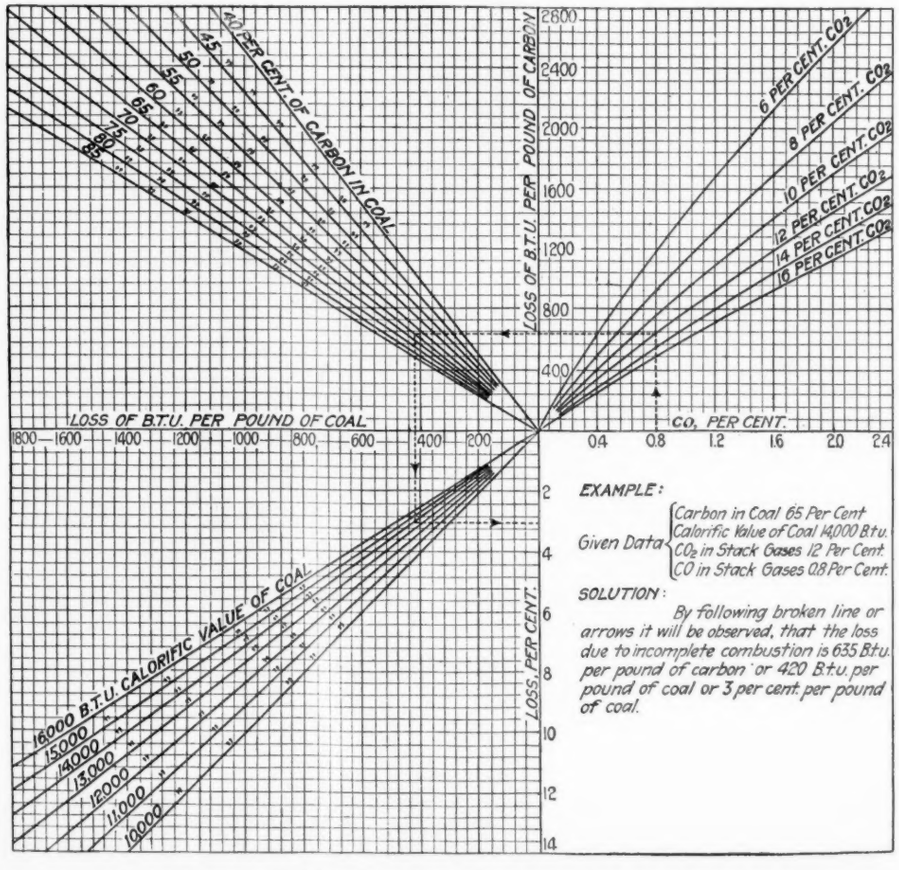


CHART FOR DETERMINING LOSS DUE TO CO IN THE FLUE GAS

Indicating the Ammonia Compressor--III*

By Robert H. Karl†

SYNOPSIS—Reproductions of many actual diagrams are discussed. The troubles they reveal and how these were corrected are told.

Fig. 12 shows a diagram from a compressor with a suction-valve spring that is too stiff. This trouble may also be caused by the valve stem binding in its guide or valve cap, or by too small valves and ports for the admission of the gas. The line *AA* shows the suction gage pressure to scale as indicated by the gage. Sometimes the suction-pressure line will be smooth, as in Fig. 12A, also from the foregoing causes, but more generally the smooth straight line is caused by too small suction-valve area, port area or small suction pipes, excessive friction of gas in the suction pipes or in the refrigerating coils. The part of the diagram between lines *B* and *C* represents a loss of compressor efficiency because the machine is not filling with gas at the gage pressure. If the port or valve area, suction-pipe area, or excessive friction, etc., is the cause, speeding up the machine will reduce the efficiency still more; if port and pipe areas are ample and no excessive friction exists, the trouble is in the valve spring or the valve itself.

Fig. 13 shows a diagram from a compressor in which the discharge pressure is too high. This may be produced by small discharge valves, small pipe area or by too stiff valve springs. More power is required than would be necessary if the valve springs were not so stiff.

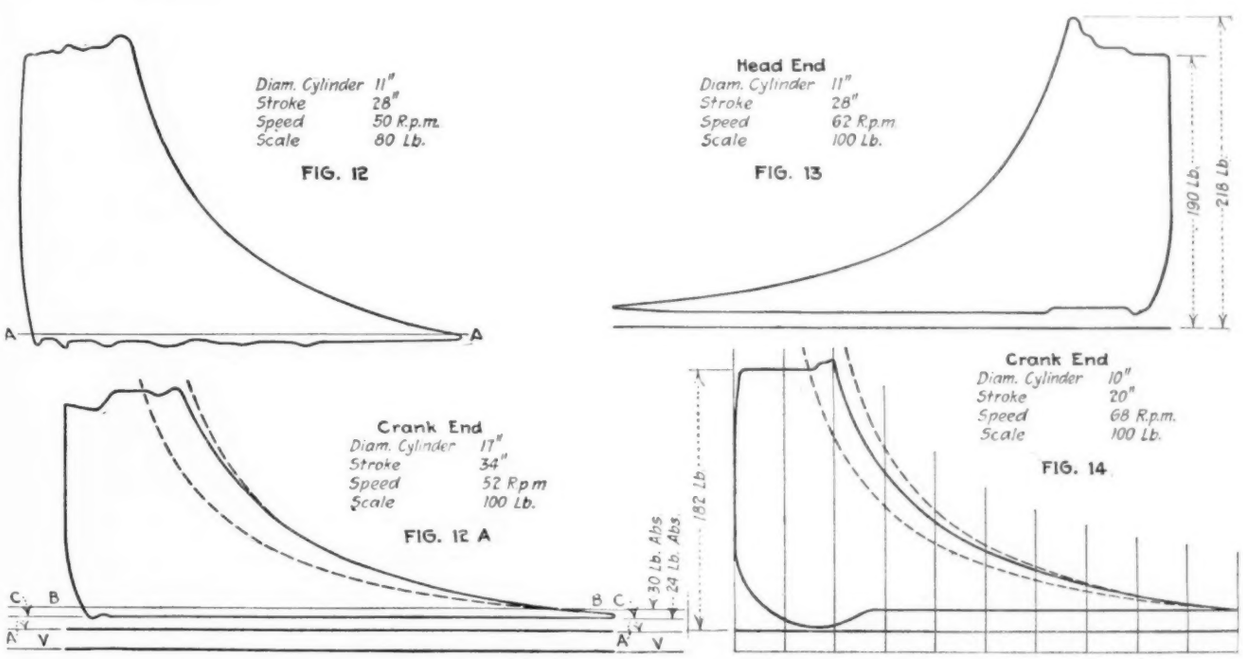
Fig. 14 is from a compressor that has a suction valve that sticks or works sluggishly. This causes the pressure in the cylinder to drop too low at the beginning of the suction stroke.

Fig. 14A shows another form of sticking suction valve.

Fig. 15 is from a compressor of the vertical single-acting type. This is from a small plant having but the one machine, and in midsummer a reduction of capacity was noticed. The valves were exchanged, a reserve set being on hand, with no results. The cylinder head was then removed, the cylinder and piston examined, but nothing found wrong. The machine was assembled, and when the valves were again examined no defect could be found in them.

The cylinder head was again removed and the gasket examined and nothing wrong noticed. The gasket was removed, and after closer examination it was found that there was a split in the gasket about one inch long, directly over the partition that separated the suction and discharge ports. This split was closed so neatly that if the gasket had not been removed it would not have been discovered—at least not so soon. A new gasket remedied the trouble. This incident illustrates how deceiving things are sometimes and how careful one must be in looking for defects in compressors.

Fig. 16 is from a horizontal double-acting compressor where the valve-cage seats in the cylinder heads are a

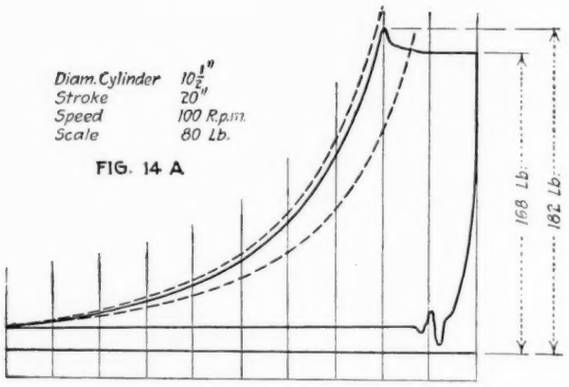


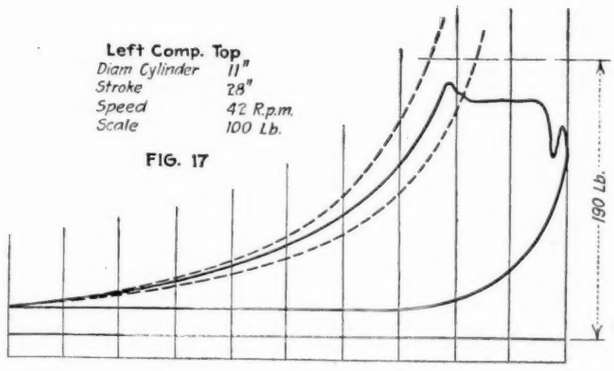
FIGS. 12 TO 14. DEFECTS REVEALED BY THE INDICATOR

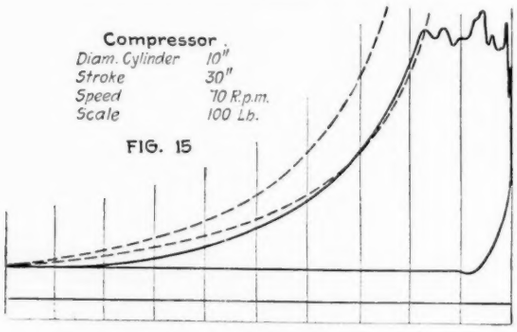
Fig. 12—Suction-valve spring too stiff. Fig. 12A—Suction-valve port too small. Fig. 13—Discharge valves too small or having too stiff springs, or discharge pipe too small. Fig. 14—Suction valve sticks or is too sluggish

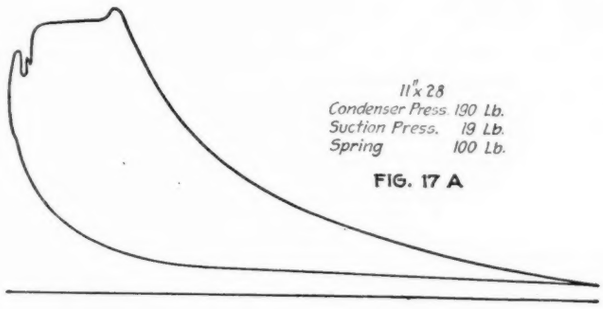
*For Parts I and II see "Power," Apr. 25 and May 16.

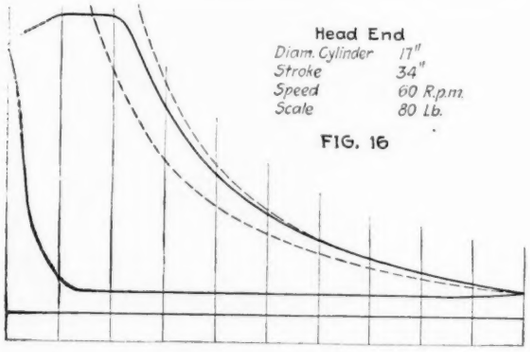
†Engineering department, Anheuser-Busch Brewing Association, St. Louis, Mo.

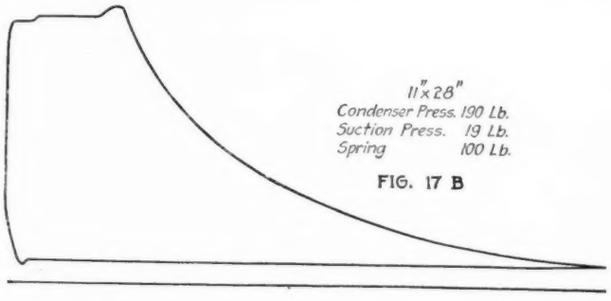


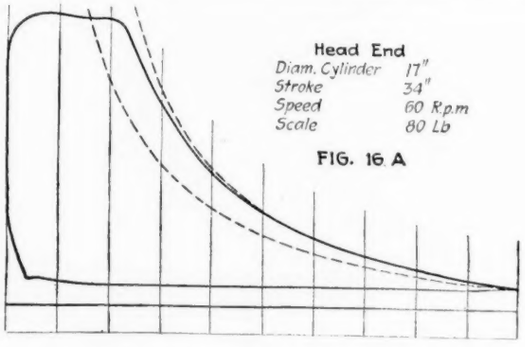


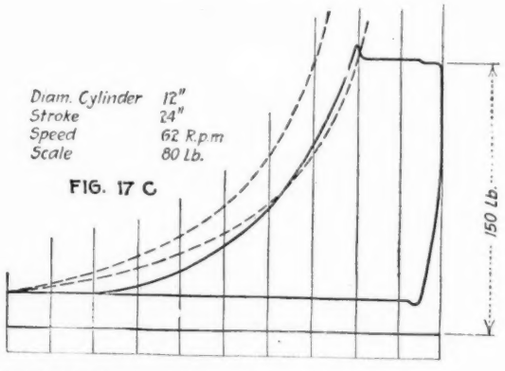












FIGS. 14A TO 17C. DIAGRAMS INDICATING DEFECTS IN AMMONIA COMPRESSORS

Fig. 14A—Another indication of a sluggish suction valve. Fig. 15—Partition between discharge and suction valves split. An unusual trouble. Fig. 16—From double-acting compressor with leaky valve cage. Fig. 16A—The valve cage made tight. Fig. 17—Sticking discharge valve on vertical single-acting machine. Fig. 17A—Similar to Fig. 17 but caused by too little cushion for discharge valve. Fig. 17B—Effect on Fig. 17A of another hole drilled in valve-cushion cap. Fig. 17C—Hole in cushion cap not in proper place.

ground joint; one of these was leaking. After grinding the cage to a good seat, Fig. 16A was obtained.

Fig. 17 was taken from a vertical double-acting compressor. Notice the hook caused by the discharge valve sticking when closing. Nothing was suspected wrong with this machine, and it was only revealed by application of the indicator. Another valve was substituted, and a few days later a better diagram was obtained. Upon examination the trouble was found to be lack of oil. The defective valve action was in the upper heads, and the upper and lower heads were connected to the suction pipe in such a manner that the lower end valves got entrained liquid or oil passing along with the gas, while the valves in the upper head got only the driest gas. The valves, upon removal and examination, were found to be dry and a dry red dust was found in them. A lubricator fitted to

the suction pipe where it entered the upper head remedied the trouble.

Another defect which will show up on an indicator diagram almost exactly like Fig. 17 is a valve not properly cushioned, causing sticking, as shown in 17A. Most designs of valves have one or more small holes in the valve-cushion cap, to allow a free action or a cushioning effect. Neglecting these openings interferes with the proper action of the valve. Sometimes it requires experimenting with these holes to get good valve action, as one small hole might not be enough. It might require three holes, depending upon its condition; then again, there might be too many holes or only the one hole and that one too large. Fig. 17B shows the effect on 17A after another small hole had been drilled in the valve-cushion cap.

Fig. 17C shows poor valve action because the hole was not in the proper place, which is explained by inspection of the figure. The diagram indicates that at the beginning of compression there was no increase of pressure; in other words, there was a large leak. An examination of the suction valve revealed the defect, illustrated in Fig. 17D, which shows a suction-valve stem, guide and cap. The cap had a small hole drilled in the side as at *A*, and when the valve was closing gas above the nut could

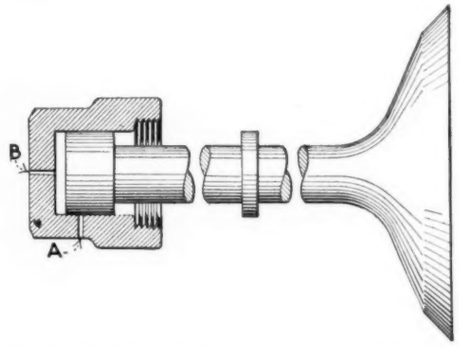


FIG. 17D. VALVE STEM, GUIDE AND VENTED CAP

escape through this hole, but when the nut passed *A*, gas left above was compressed, causing a pressure sufficient to prevent the valve from closing. A hole was drilled in the top of the cap, as at *B*, and this remedied the trouble.

[*The next article shows some interesting diagrams taken from compressors troubled with defective suction and discharge valves. The reader is again reminded that all diagrams shown in this series are reproduced to scale and therefore offer excellent opportunities for planimeter practice and compressor calculations.—Editor*]

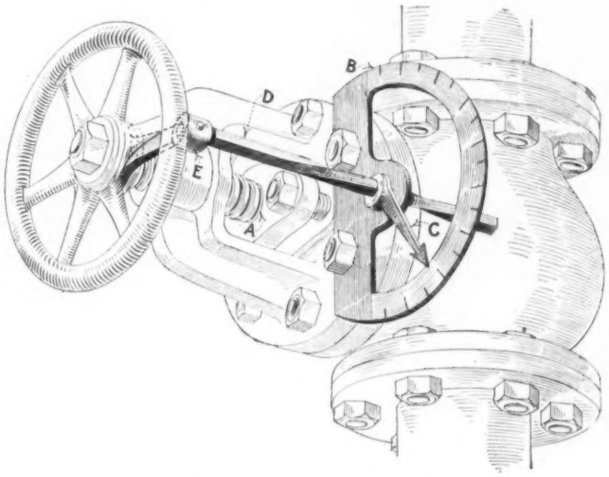
An Ingenious Valve Indicator

By S. F. Jeter

The need for an indicator or telltale to show the exact position of a throttle or other valve, particularly where it is not readily accessible for trial, is often experienced by engineers. The writer recently saw a simple and ingenious device for this purpose, which is applicable to any type where the stem travels with the valve. Such a contrivance is used on the throttle valves of the large reciprocating units at the Pratt Street power house of the United Railways and Electric Co., of Baltimore, Md., and was designed by Malcolm Wright, chief engineer.

The construction and operation are shown in the illustration, where *A* is the valve spindle and *B* a graduated quadrant fastened rigidly to the body of the valve. The pointer *C* is fastened to the quadrant, but is free to revolve over its face. The center of pointer *C* is pierced by a square hole that fits neatly over a square rod *D*.

The rod *D*, through a clamp *E*, is made to follow the movement of the valve stem in and out as the valve is operated, and the part of *D* that engages the pointer *C*



INDICATOR ATTACHED TO VALVE

is twisted so that from the open to the closed position of the valve the pointer *C* will travel 180 deg. over the quadrant.

This indicator is extremely simple to make, all the parts apparently being forged by hand and requiring little machine work. It should be useful on main steam and other inaccessible valves where a positive indication of the position of the valve is desired to be determined from a distance.

Electric Undertakings in Japan. The first electric-light plant in Japan was installed in 1887. It consisted of one home-made 75-lamp dynamo for electric lighting in Tokyo (afterward replaced by two 200-lamp Edison machines). At the end of 1888 the aggregate capacity of the generating stations had reached 500 kw. In 1889 there was installed what was called a high-tension alternating-current system consisting of one 30-kw. 1,040-volt machine of the Thomson-Houston type. The first electric railway was opened in Kyoto in 1895. In 1899 an enterprise was started for the transmission of electric power over a distance of 15-mi. at a pressure of 10,000 volts. The capacity of this plant was 300 kw. In 1907 the Tokyo Electric Co. built a hydro-electric power station at Komahashi, the capacity being 15,000 kw. The power from this station was transmitted 50 mi. to Tokyo at a pressure of 55,000 volts. In 1914 work was completed on a 14,000-kw., hydro-electric generating station near Lake Inawashiro; the power is transmitted to Tokyo, a distance of 140 mi., at a pressure of 115,000 volts. Electric undertakings in Japan have made rapid progress. At the end of 1913 the total capacity of generator stations in operation amounted to 503,541 kw., of which 278,396 kw. were driven by hydraulic power, 204,917 kw. by steam engines and turbines and 20,228 kw. by gas and oil engines. Of this total capacity 122,500 kw. are isolated plants and 15,241 kw. government-owned plants. In 1903 there were 72 mi. of electric traction in operation; at the end of 1913 this had increased to 701 mi., 407 mi. of which is double-track. The Hydraulic Power Investigation Bureau estimated that the available hydraulic power in Japan amounts to 2,295,223 hp.

To Reduce the Maintenance cost of furnace lining in stoker-fired, forced-draft boilers, a high-grade firebrick is used up to the fire line; a bauxite brick is commonly employed for this purpose.

The Effects of Dissolved Salts in Feed Water

By John B. C. Kershaw

SYNOPSIS—The author gives a résumé of the results of the experiments by Cribb and Arnaud, and Heyn and Bauer, and proceeds to show that dissolved salts accelerate corrosion.

The influence of temperature and concentration on the saline constituents of boiler water has been investigated by C. H. Cribb.[1] In the course of his article Cribb states:

> Even with the best of boiler waters a certain amount of corrosion takes place, and it is not unreasonable to suppose that in this connection the concentration is not without influence. In any case the high temperatures have a marked effect on the chemical activity of those constituents to which corrosion is usually attributed.

Giving details of a particular case in which corrosion had occurred, he cites a series of analyses of a water containing a fair proportion of magnesium oxide and much chlorine, which acted powerfully on a boiler and its fittings when worked at 140 lb., whereas other boilers, using the same water at 80 lb. pressure, suffered no corrosion at all.

In a later investigation upon the action of slightly alkaline waters upon iron, published in the same paper for July, 1900, the same chemist, working with F. W. F. Arnaud, states:

> With an alkalinity not exceeding a certain amount—dependent on the nature of the alkali present and to a less extent on the temperature—not only does action occur equal in intensity to what would occur in the absence of any alkali, but this action takes place in a very curious and interesting manner, for which at present we are unable to offer any altogether satisfactory explanation.

Discussing the practical bearings of this investigation upon the use of softened boiler-feed waters, the authors state:

> It is quite obvious that, assuming that these curious phenomena we describe really take place under the conditions which obtain in boilers, feed-water tanks, etc., they would constitute a very serious objection to the use of chemical processes of water softening and also to the employment of alkaline waters of any sort for steam-raising purposes, for even the smallest degree of alkalinity in a feed water will, by the concentration that takes place in the boiler, be raised to thirty or more times its original amount, and therefore the whole range of alkalinity with which action occurs is well within the conditions that would occur in practice.

The experimental figures obtained in the course of this investigation proved that slightly alkaline solutions of sodium chloride and sodium sulphate acted corrosively upon steel strips similar in all respects to the plates used for steam boilers, and that this action increased with the degree of concentration of the chloride or sulphate. The authors summarize some of their conclusions by saying:

> In the case of boilers, especially high-pressure boilers, the high temperature prevailing increases the amount of decomposition undergone by practically all the saline constituents of natural waters, and therefore it would naturally be expected that the possibility of pitting would increase rather than diminish as the temperature rises.
>
> There are some factors that tend to lessen, if not altogether to prevent, pitting in a boiler, and there can be no doubt that these are largely operative, otherwise pitting would be universal with all softened waters, from the cause under discussion. The first of these counteracting tendencies is that most softened waters give a deposit when heated, which is generally sufficient to cover the plates and tubes with a more or less protective coating. If it is not, steps are taken to produce such a coating by what may be called artificial means. Secondly, the rapid circulation, especially in the case of tubular boilers, would almost certainly prevent anything in the nature of the growths seen in the laboratory experiments. There are, however, in most boilers, and especially in the non-tubular kinds, certain places where the circulation is very much slower, and it is the experience of most engineers that it is in these spots that pitting most frequently occurs.

"The Memorandum," prepared by C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association in 1911, was devoted largely to the subject of corrosion in steam boilers, and the results of investigations by Professors Heyn and Bauer of the German National Physical Laboratory, carried out in 1908-10, were extensively quoted.

After referring to the well-known and admitted corrosive effects on boiler plates of air and other dissolved gases in boiler-feed waters and to the influence of such dissolved gases upon the experimental results of Heyn and Bauer and other observers, Mr. Stromeyer quotes a large number of figures obtained in the experiments of the two German chemists. As regards the action of the high pressures and temperatures now used upon sodium carbonate and also upon sodium chloride in presence of alkali, it is stated that

> Carbonate of soda is also affected by the temperatures which are met with in high-pressure boilers, where this salt gradually gives off its carbonic acid till the water grows caustic and injury results to the brass fittings. The worst pitting effects, in the present experiments, were noticed with solutions containing both sodium chloride (common salt) and sodium carbonate (common soda), but there are doubtless other combinations that are still more injurious.

Summarizing the conclusion which he draws from the experiments of Heyn and Bauer, Mr. Stromeyer states:

> Although the present experiments, in spite of the care and trouble bestowed on them, are somewhat disappointing, they do at any rate point to two very important conclusions, which are confirmed by practical experiences. These are, first, that most ammonia salts are powerful corroders of iron, which accounts for the serious corrosion sometimes met with in boilers fed with water that is contaminated with waste liquors from gas works, and secondly, that when carbonate of soda is added to brackish water (water containing common salt), then severe pitting occurs, although the average corrosion may not be extensive.

The importance of this last statement lies in the fact that many hard waters contain some of the lime in the form of calcium chloride. On softening such a water with sodium carbonate, one obtains sodium chloride left in solution, and if an excess of the alkali has been used, as it generally is, one will obtain in the boiler the conditions favorable to severe pitting.

The cases dealt with below are examples of corrosion and pitting that have been submitted to the writer in the course of his practice as an analytical chemist. It is important to observe that internal corrosion or pitting had already occurred in these cases, and that the chemist was called in to advise as to the probable cause and to suggest a remedy.

The first case is one in which pitting and corrosion of the feed pipes and tubes of a water-tube boiler occurred,

[1] "The Analyst," June, 1900.

the feed pipes being specially affected. The water used in this boiler was a natural surface water of exceptional purity, and it had been treated with soda ash before use. A sample of water from the boiler itself was first taken and analyzed. This sample contained 81.5 parts of dissolved solid matter per 100,000 of water, in addition to large amounts of iron oxide in suspension. The iron oxide was of course due to and the result of corrosive action. The character of the dissolved salts was, however, important, and a further examination of this water proved that it contained chlorides equivalent to 45 parts of sodium chloride per 100,000 of water. The total hardness test was 13.3, and magnesium was present in very small amount, proving that the chloride was chiefly present as sodium chloride.

The presence of this large amount of chloride in the boiler was considered sufficient to account for the corrosive action on the tubes, and the next point was therefore to investigate the two sources from which it might have come—namely, the soda ash and the original feed-water supply. A sample of the latter showed total dissolved solids equal to 9 parts per 100,000 and a total hardness of 4.56 deg., with chlorine equivalent to 2.8 parts of sodium chloride. Clearly this water could not have produced the strong solution of chloride present in the boiler with ordinary care as regards blowing-off, and thus the soda ash was indicated as the origin of the impurity. A test of a sample of the latter was therefore made. It showed 49.5 per cent. of sodium chloride and only 46.3 per cent. of carbonate. This was the most adulterated commercial product that has ever come into the writer's hands, and it proves the need of testing such materials from time to time.

Purity of Soda Ash Important

The analyses made had now indicated the best way to remedy the trouble. The boiler was washed out, the use of soda ash was discontinued, and the pitting and corrosion have ceased to give any special trouble.

The second case was similar to the first and related to the corroding of the steam drum and valves of a water-tube boiler. The water in the boiler was analyzed and found to contain 45 parts total solids per 100,000; the total hardness was 13.87, and chlorides equal to 27.80 parts NaCl per 100,000 were found. The water was alkaline and contained only traces of magnesium salt.

The corrosion here was attributed to the chloride that had accumulated in the boiler by using an impure soda ash containing 1.8 per cent. sodium chloride and only 72.54 per cent. sodium carbonate. The use of softening chemicals in this boiler was discontinued.

The third case was one of gun-metal boiler fittings and occurred with a feed water obtained from a spring near the works. This water contained 17.6 parts of total solids per 100,000 of water and 12.8 parts of calcium and magnesium carbonates and sulphates equivalent to 9 deg. total hardness. It was therefore not a bad feed water, and its use without softening was not sufficient to explain the corrosion of the boiler fittings. A sample of water drawn from the boiler, however, was found to contain 689 parts dissolved salts per 100,000 of water, 43.2 parts, or 6 per cent. of this total, being organic. The incrustation on the boiler fittings was found to contain both chlorides and sulphates of the metal. The corrosion then was evidently due to an accumulation of dissolved salts in the boiler and to failure to blow off the boiler at sufficiently short intervals. Regular blowing off at shorter intervals at once stopped the trouble.

Another case is one that has occurred recently and has been the subject of litigation in the Vice-Chancellors Court of the Duchy of Lancashire. The action was brought by a group of companies engaged in the cotton-spinning, weaving and dyeing industries in Southwest Lancashire, to restrain a large colliery company, owning and working several coal pits in the same neighborhood, from polluting the water of a brook which all the plaintiffs used for the supply of their boilers and works. The water pumped from the defendants' pits was charged with extraordinarily large amounts of calcium and other salts in the form of chlorides and sulphates, also with iron salts which led to the formation of insoluble hydrated iron oxide and carbonate when the water was exposed to the air, and the case really hinged upon the question whether this water, after the softening treatment to which it was subjected before passing it into the brook, was fit to put into any steam boiler. The water after softening treatment contained on the average 700 parts of dissolved salts per 100,000, chiefly as sulphate and chloride of soda, and the experts retained for the plaintiffs asserted their belief that such a water was unfit for use as a boiler-feed water.

Injunction Against Polluting Stream

The action took up 14 days. Much scientific and other evidence was called, and the case was stated to be one of importance, not only to the coal owners, but to all engaged in the textile industry.

The vice-chancellor in his judgment stated that in earlier proceedings an arrangement was made whereby the defendants were not entitled to turn into the stream water of a character less pure than that which reached the plaintiffs' works in 1891. The defendants had failed to displace evidence which, he thought, was conclusive, that the stream (and its added components) when it reached the mills was not in such a pure condition as in the year named. It seemed to him that there were considerable difficulties in the way of the defendants in making out any prescriptive right to turn polluted water into the stream. He therefore granted an injunction in the terms of the order asked for.

Considering these cases of pitting and corrosion in conjunction with the theoretical researches of Cribb and Arnaud and of Heyn and Bauer, one would find it difficult to doubt that under usual conditions of boiler temperature and pressure sodium chloride, and possibly sodium sulphate, in presence of an alkali, do attack and corrode plates and fittings.

Sodium Chloride in Marine Boilers

Engineers of the older school of course will disagree with this statement and will ask, if this is so, why marine boilers have been working for so many years in the past with salt water in their feed without serious mishaps and why almost all the engineers' handbooks state that a concentration equivalent to 5,500 grains per gal. of sodium chloride or other dissolved salts is allowable in steam boilers before blowing off. The first is untrue, and the second only proves how conservative engineers are and how they cling to formulas long after their value is gone.

The present-day marine engineer tries to keep sodium chloride out of the boilers and condensers because he

knows what troubles are in store for him if he permits its entrance. The leakage of sea-water into the condensers of marine engines in the past has caused ships' engineers more worry than anything else that has happened to them at sea. The latest types of marine condensers are in fact designed and constructed so that they may be gas-tight as well as water- and steam-tight, and the aim of the marine engineer now is to keep the boiler-feed water as pure and as free from all dissolved impurities (gaseous and solid) as he can.

Some Successes and Failures of Diesel Ships*

By T. O. Lisle

SYNOPSIS—The author champions the four-stroke-cycle Diesel against the two-stroke-cycle type for marine work and backs up his argument by figures and reports from ships in actual service. His remarks have no reference to engines of the semi-Diesel type.

Numerous articles have appeared in the technical press concerning Diesel-engined ships—some reliable, and others based on translations from foreign journals dealing usually with ships that have been in service for short periods only. Consequently many owners or their superintending engineers have unconsciously obtained a misleading impression of the situation. Much harm also was wrought by two European builders of stationary Diesels who, during the first Diesel boom, sold licenses and working drawings for seagoing ships to well-known English and Continental shipbuilders at a time when they themselves had never installed a single Diesel engine in a seagoing vessel. American naval architects and engineers have visited some of these ships, and what they have seen has not yet induced them to abandon steam, they being, of course, unaware of the circumstances of their construction. The owners have, naturally, refrained from placing repeat orders.

Although many American shipowners believe that the day of the reliable motor ship has not arrived, it is a fact that one Danish Diesel-engine firm already has launched 18 large vessels and has actual orders for 45 additional ships to the total value of $30,000,000, which are to be completed by 1922. Another firm, in Holland, that has completed 22 commercial Diesel ships, is overwhelmed with orders, and three of the largest shipbuilders in this country have recently acquired licenses to build these engines.

Shortly after the Diesel, in its adaptation to ship propulsion, first sprang into prominence in Europe, many became strong advocates of the two-stroke-cycle principle, although at the time there was not a single motor of that type of over 300 hp. in service. The two-stroke-cycle motor has an apparent advantage if one considers the extra power developed with the same cylinder dimensions; but in existing ships the average weight and overall size has not been materially less than with four-stroke-cycle engines. Hence the extra cylinder power does not seem important at the present stage, reliability being far more essential.

During the twelve years that Diesel engines have been installed in commercial ships the vessels here listed have had their motors removed or rejected.

The "Wandal's" motors were taken out in 1914 after nearly eleven years' service—not because they were unsatisfactory or worn out, but because the hull was old and became obsolete for the work required. In fact the engines are now driving dynamos on land. The "Tynemount" had high-speed land-type Diesel engines, driving generators, the latter operating a central motor. According to Lloyds' reports the electrical machinery did not meet with expectations, so the plant was removed.

	Power, B.Hp.	Type	Original Engine	Present Engine
"Eavestone"	800	Two-stroke-cycle	Westgarth-Carels	Steam
"Sebastian"	1,600	Two-stroke-cycle	Polar	Werkspoor four-stroke-cycle Diesel
"Russ"	800	Two-stroke-cycle	M. A. N.	Kolomna four-stroke-cycle Diesel
Petroleum Steamship Co.	2,600	Two-stroke-cycle	Frerichs-Junkers	Steam
"Toller"	360	Two-stroke-cycle	Polar	Steam
"Priemus"*	2,600	Two-stroke-cycle	Junkers-Weser	Steam
"Netherton"	200	Two-stroke-cycle	Thornycroft	Bolinders hot-bulb
Standard Oil Co. tank barge	300	Two-stroke-cycle	M. A. N. (Nlseco)	Bolinders hot-bulb
"Wandal"	360	Four-stroke-cycle	Nobel-Polar	Hull out of date
"Tynemount"	600	Four-stroke-cycle	Mirrlees, Bickerton & Day	Steam

*Engines were rejected on the test-bed.

The main reasons for removing the engines from the ships in the foregoing list have been cracked cylinders, cracked heads, cracked pistons, faulty air compressors, accumulation of carbon deposits, lubricating difficulties and main-bearing troubles. The last three troubles seem to have been most serious and difficult to overcome, as they have caused long delays with some ships. According to a report given the writer, the main bearings of the two 850-hp. step-piston type engines of the "Sebastian" wore away to an alarming extent.

One reason for main-bearing troubles with two-stroke-cycle engines is the constant pressure to which they are subjected, tending to make lubrication difficult and unsatisfactory. On the downstroke is exerted the working pressure, and on the upstroke the pressure against the compression increases to about 450 lb. per sq.in. As this occurs every revolution, the bearing never gets any relief and there is one continuous grind. Increasing the bearing surfaces does not seem to meet the need, and the solution of the problem perhaps lies in the double-acting two-stroke-cycle engine. However, other serious problems have confronted the designer of the double-acting engine, although one can hardly foretell the future.

With the four-stroke-cycle engine, the wear is by no means small, but there are two reliefs on the bearings every alternate revolution. On the exhaust stroke in

*This answers a number of the points raised by Mr. Illmer in the May 30 issue.

particular the upward inertia of the heavy piston tends to lift the crankshaft from its bearings and so allow the lubricating oil to get over the under halves of the bearings.

C. Zulver, marine superintendent of the Anglo-Saxon Petroleum Co., owner of 9 Diesel-engined ships, pointed out before the Institute of Marine Engineers that while the advantage of increased power for similar dimensions is very attractive, a shipowner has to consider reliability for continuous work at sea. In this respect the four-stroke-cycle engine has, in his opinion, proved its superiority. Careful study of the two-stroke-cycle Diesel has brought Mr. Zulver to the conclusion that its principal drawbacks are: (1) Double heat generation; (2) ports in bottom of cylinders making the permanent tightness of a liner doubtful; (3) complications with scavenging pump; (4) higher fuel consumption, probably 10 to 15 per cent.; (5) no relief to moving parts, thus necessitating larger bearing surface; (6) long trunk piston necessary to close ports in bottom of cylinder which does not make a desirable mechanical arrangement; slight wear and tear of guide may result in "seizing" of piston.

Repeat Orders for Diesel Ships

Another important matter is that there does not appear to be a single instance on record of a shipowner giving a repeat order for a high-powered two-stroke-cycle Diesel-engined mercantile ship after he has had one in service for a while. The reverse appears to be true with the four-stroke-cycle type. For instance, the East Asiatic Co. has eight vessels with Burmeister & Wain engines; the Anglo-Saxon Petroleum Co., nine with Werkspoor engines and more on order; the Nordstjernan (North Star) Co., six 9,625-ton Burmeister & Wain ships in operation; the Russian Government has eight 1,000-hp. gunboats with Nobel engines; Merkulew Bros. have a half-dozen four-stroke-cycle motor tugs and ships in service; and the Mercury Transportation Co. is constantly ordering new mail and passenger ships with Kolomna engines, as are also the Nobel Bros. Naphtha Production Co., the latter using chiefly tankers and towboats. Obviously these shipowners would not place the repeat orders if the results of their existing motor ships did not warrant it.

Ships with four-stroke-cycle engines have experienced troubles—some serious; but these troubles have mostly been such that they were overcome without interfering with the regular working schedule of the ships. Furthermore, they have been caused generally through faulty design and lack of seagoing experience, and not through faulty principle.

Large Cylinders Increase Heat Problems

As the cylinder diameter increases, the wall surface increases rapidly, also the jacket water is farther and farther away from the heat center and the wall thickness is greater. These factors are not so applicable to a four-stroke-cycle engine, because of only half the combustion strokes, incidentally greatly reducing the average temperature; but even with this type having cylinders over 16-in. bore it is usually necessary to water-cool the pistons.

Many believe that Diesel engines must be constructed with extraordinary care—as in a watch factory. It is the writer's opinion, however, that what is needed is just sound marine-engineering practice, combined with knowledge of the materials, methods of casting and the requirements of the Diesel design, this being obtained only by experiments and experience. The design is the most difficult feature. One European firm has proceeded from the first on the theory that the marine Diesel that could not be repaired in any part of the world was of no use in a ship. Moreover, this firm neither grinds nor laps the cylinders of its engines.

Repair Accounts of Diesel Ships

Through the courtesy of several shipowners the writer is enabled to give the working results of several motor ships having different types and makes of Diesel engines.

The cargo ship "Cornelis," of 600 tons, was one of the first coastwise motor ships, being placed in service in December, 1910, since which time she has covered about 90,000 nautical miles. The engine, a four-stroke-cycle Werkspoor, is of only 190 b.-hp. The cost of repairs has been about $500 per annum for the main engine and $125 for the auxiliaries, and the total time lost for machinery repairs has been three to four weeks per year, during which time dry-docking for painting and bottom scraping was carried out.

The Hamburg-American Line has two motor ships—the "Christian X," of 7,200 tons, driven by Burmeister & Wain four-stroke-cycle Diesels, and the "Secundus," of 7,350 tons, driven by Blohm & Voss two-stroke-cycle engines. The cost of repairs to the main engines (new cylinder heads had to be fitted as the cooling-water spaces were too small) and auxiliaries of the four-stroke-cycle ship has been heavy, being $5,200 per annum, when 250 days at sea and 115 days in harbor, but all ordinary repairs could be made in regular harbor time. The cost of repairs to the two-stroke-cycle ship they were unable to furnish. However, following is the Hamburg-American Co.'s own comparison of the working expenses:

WORKING EXPENSES PER TON AND 1,000 MILES

Sister steamship	1.32c.	100 per cent.
Two-stroke-cycle motor ship	1.2c.	91 per cent.
Four-stroke-cycle motor ship	0.986c.	75 per cent.

This shows a saving of 25 per cent. for the four-stroke-cycle motor over the steamship and 16 per cent. over the two-stroke-cycle motor ship. These figures hold only up to the beginning of the war, as the ships are now laid up.

The twin-screw Burmeister & Wain engined cargo ship "Siam," a vessel of 9,700 tons and 3,000 i.hp., on her first voyage, lasting 5½ mo., covered nearly 28,000 mi., of which 40 days was a continuous run. At the end of this voyage, according to the builder, she spent only six days in her home port discharging cargo, repairing and overhauling. The total repairs for this voyage cost $296.26c., of which amount $126.88 was to the main engines and auxiliaries, the remainder being to the hull, propellers, thrust bearing and deck machinery. The labor on these repairs was as follows:

1. All crossheads and guides examined on board	$2.25
2. Pistons of main engines removed on board for examination	78.92
3. Seven manometers removed, repaired and justified	14.18
4. Six main engine exhaust valve spindles repaired, cast iron welded on, machined and ground together for the main engines	29.54
5. One auxiliary engine exhaust valve repaired, as above	1.99
Total	$126.88

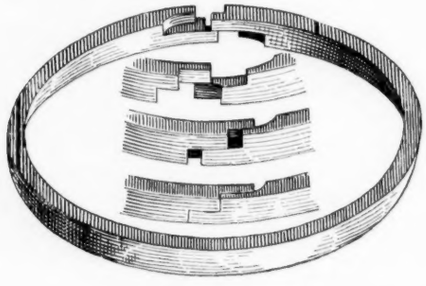
After the second voyage the repairs were higher, amounting to $749.72, of which $240 had nothing to do with the engine-room machinery. The repairs to the main engines and auxiliaries were as follows:

1. Crosshead brasses for port and starboard engines examined on board.
2. Four fuel-valve spindles and 16 bottom pieces for fuel valves for main engines.
3. One piston stud for air pumps of the main engines ground, white metal cast into the crosshead brasses of same and these bored out.
4. One suction and one pressure valve for fuel pump for main engine.
5. Seven plate liners for thrust bearing.
6. Four exhaust valves repaired, eight new spindles with loose seats and nuts made for auxiliary engines.
7. Fuel valves examined and repaired, two new bottom pieces made for auxiliary engines.
8. Two hardened fuel-pump pistons for auxiliary engines.
9. Eight piston rings for auxiliary engines.
10. Three inlet pipes for auxiliary engines made and fitted up on board.
11. Two brackets for turning gear for auxiliary engines.
12. Four thermometer pieces.
13. Filter for fuel oil altered on board, examination and joining of the filters, and three drain pipes arranged for drain-cocks.
14. Four filters for lubricating oil examined and repaired, new metal gage soldered on, two new filter baskets, and two new funnels made for same.
15. Discharge pipe for bilge pump made and joined on board.
16. Assistance in the engine room, crank pit cleaned, etc.

During these two voyages all the work done at the ports where the ship stopped was the taking out and examining of the exhaust valves, compressor valves, inspecting the bearings, etc., just to insure that everything was all right.

Chalsmith Piston Ring

A piston ring with interlocking joint, illustrated herewith, has recently been placed on the market by the Chalsmith Sales Corporation, 2 Columbus Circle, New York City, and is made in the usual variety of sizes. These rings are of gray iron cast singly. The skin



A PISTON RING

of the iron is left on the inside, to insure resiliency. The joint is machined to close limits and is practically gastight. It can open from $\frac{3}{16}$ to $\frac{1}{4}$ in., according to the size of the ring, before there is passage for the gas.

Enormous Loss Is Due to Condenser-Tube Corrosion—The corrosion of condenser tubes of our warships alone involves an annual expenditure of about $2,000,000. If $1,000,000 were spent on research on this problem, with the result of reducing the damage to one-half, the outlay would be compensated in a few months' time. Besides that, our fleet would be stronger because more ships would always be available for immediate active service.—From an address at a joint meeting of the New York Sections of the American Chemical Society, the American Electrochemical Society and the Society of Chemical Industry.

A Leakage Is Occasionally Started during the period of raising steam. For instance, the blowoff cock may not be tight or the feed valves may be leaky, in which cases water will at first show in the gage-glasses, but as soon as there is any pressure, leakage commences. The resulting collapses are generally of a serious nature, because they take place while steam is being generated. These cases are of the nature of unforeseen accidents, with which night watchmen can hardly be expected to deal, and it is desirable to instruct them not to proceed with the raising of steam whenever they notice anything unusual about a boiler, for it is far better to have a delay of a few hours than to have a shutdown for days because the boilers have become useless.—C. E. Stromeyer.

JUST FOR FUN

"Sure It's Case Aqual," Says Pat

"When elevator cables are placed upon the sheaves with the strands all slanting the same way [Fig. 1], as they are on your elevator," said the inspector, "the thrust is all in one direction, which is objectionable. They should be installed so as to equalize this thrust [Fig. 2]. We will therefore require you to remove two of your elevator cables and change them end for end. Your equipment will then be in conformity with the rules of our inspection department." When the engineer asked, "Is a right-hand screw a left-hand screw when looked at from the other end?" The inspector said, "No. Why?"—Burt N. Everett, Jamestown, N. Y.

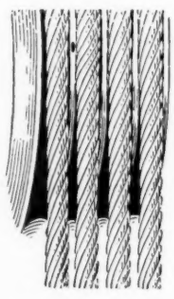


FIG. 1. AS THEY NOW ARE

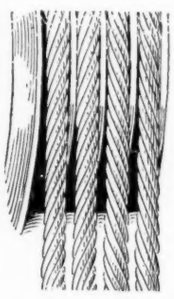


FIG. 2. AS THEY WILL (NOT) BE

A Natural Mechanic

A farmer who had a gas engine on the farm, an automobile, a feed cutter, etc., dropped into a city power plant to look around. The engineer explained the operation of the stokers, the pumps and other units. After completing the rounds, the farmer asked: "Did you learn how to run all this machinery just by working at it or did you take a correspondence course and learn it that way? I am a natural engineer. It was born in me. I inherited it from my father. He ran a threshing machine sixteen seasons and a sawmill engine about as many winters. You see, I just couldn't help being a mechanic."—W. C. Vernon, Chicago, Ill.

No Certificate for Him

The applicant for an engineer's license who failed to pass was heard to exclaim, "I'd like to find the man who said 'ignorance is bliss.'"—J. E. Noble, Toronto, Can.

Resistance to the Flow of Steam, or the total loss of head at the pipe entrance and through globe valves, is generally taken as equal to $1.505\frac{V^2}{2g}$, when V = velocity of the steam in ft. per sec. and g the acceleration due to gravity (32.16 ft. per sec.). This is about equal to a length of pipe determined by the formula $L = \frac{114D}{1 + (3.6D)}$, when L = length of straight pipe and D = diameter of pipe in inches. The results obtained give the following approximate additional length of pipe of a given size as equal to the loss through one globe valve or at the pipe entrance:

D in. =	1	1½	2	2½	3	3½	4	5	6	7	8	10	12	15	18	20	22	24
L ft. =	2	4	7	10	13	16	20	28	36	44	53	70	88	115	143	162	181	200

The resistance of a right-angled elbow is about two-thirds that of a globe valve, as found by the foregoing formula.

Editorials

Making The Best Use of Fuel

That there is a civic as well as an economic question involved in the prodigal waste of the fuel wealth of the country, and that it is not given the serious attention that it deserves or will soon demand, goes almost without saying—and unfortunately, also the waste goes on without much being said about it.

The time is coming when the conservation of fuel will be rightfully and generally conceded to be a public, national matter, and the use and waste of fuel subject to regulation. Then the user, large or small, will no longer have free rein, to consume a ton where a hundredweight could be made to do the necessary work.

This is not so radical or extreme as may at first appear, for at present, with the laws in force in some states, public-utility rates are fixed by a commission empowered by law to see that the consumer is *reasonably* served at a *reasonable* rate and at the same time that a *reasonable* rate of earning is secured to the investor in the enterprise. If, however, the station accounting shows that a fair return is not being earned on the capital involved, the commission proceeds to investigate the cause and order the remedy. If it proves to be simply a case of mismanagement, the course of treatment and the remedy are comparatively easy, but if it is found that antiquated or uneconomical machinery or equipment is being used, a better installation is ordered to meet the requirements. Rates may be increased only when in the judgment of the commission the local or unavoidable conditions are such as to justify an increase.

Confiscatory? Not at all—simply seeing that the fellow who has been given certain franchises and permits and, by reason of his position in the field, is the only producer from whom the public may purchase a commodity does not overcharge, but at the same time safeguarding the investment.

A short step farther and a state or national commission will require from users a strict accounting of their stewardship of the B.t.u. intrusted to them from the nation's great storehouse; whether two, five or ten times the necessary amount is being used; not whether the individual is satisfied or chooses to waste, but rather the broader view of conservation, that the cost of fuel is made proportionately greater, more burdensome to others.

Then will come the question of the utilization of exhaust steam. No one will be permitted to throw away three-fourths to nine-tenths of the heat produced by the fuel, as at present, if there is a possible means of its utilization. Nor will it be considered proper utilization to simply condense it for that is begging the question. Heat thrown overboard in the condensing water is "somebody's heat" just the same as the cloud of steam from the exhaust head. The steam wasted from a plant of moderate size can easily supply a residence block with heat in winter during its operating hours, without excessive extra cost, and in summer with an abundance of hot water and at the same time the back pressure on the engine can be reduced by using heaters or condensers, without the cost of pumping the water, by the legitimate use for distribution of the city water supply.

The escape of steam from stacks and sewers, so often to be seen even during the coldest weather, when it might be used, perhaps on the premises or next door, constitutes the greatest of travesties on our self-styled modern efficiency, conservation and "all around superiority" that can well be imagined.

Convention-Time Thoughts

For some weeks past and on for the next few months to come many conventions of engineering and allied organizations have been and will be held.

If one will but take the time to step out of his own small though busy sphere and survey the present status of engineering, the perspective will show that the milestones of progress mark new achievements and more extensive responsibilities. This is particularly true of mechanical, electrical and chemical engineering. It is in these convention times that one's thoughts turn more upon such matters than they do ordinarily.

Every progressive power-plant engineer is conscious that the gains made by his brethren in the professional grades must of course mean steps forward for himself. The colleges and technical schools have turned out graduates this year in numbers exceeded by few if any others. The number of students enrolled this year will likely be greater than usual. The wind of industrial preparedness blows good to the technically trained.

Of late years the gap between the operating engineer and engineers of the professional grades has steadily diminished. The new impetus that conditions of the last two years have given to technical training, or rather the need of it, means that the studious effort and praiseworthy energy shown by operating men must be manifested with even greater zeal than heretofore. How best to go about doing this will be the most serious thought in conventions where men meet to shape the destinies of themselves and their organizations.

Utilize the Exhaust Steam

Steam-turbine operation in the power plant has brought about changes, in so far as auxiliary units go, in the utilization of the exhaust steam from them.

Heat that goes to an engine in the form of steam must come out in the form of work, exhaust steam or heat lost by radiation. If eighty per cent. of the heat of the steam escapes from the engine as exhaust, the utilization of that steam is of importance.

It is no uncommon thing to see steam issuing from the exhaust head of a plant that is running condensing, sometimes to such an extent that one is led to wonder if something is not radically wrong with either the design or the operation of the plant. Such practice is evidence of an avoidable loss.

Some few power plants have lately taken care of the surplus exhaust steam over that necessary to heat the feed water to the proper temperature before it goes to the boilers, by arranging the piping so that all excess steam that would under ordinary circumstances escape to the atmosphere will go to the low-pressure stage of the main turbine.

Arrangements for the utilization of this exhaust steam that cannot be used in the feed-water heater will reduce the makeup water to a minimum. In one plant where this idea is carried out, the makeup water is less than one and one-half per cent. of the total used in the plant. The less raw water used in a plant the less trouble from scale, the less frequent the cleaning periods for the boilers, the less coal burned and the higher the plant efficiency. Why not use all the exhaust steam in every plant operating condensing?

What is the Outlook?

As we go to press, the war cloud hangs lower over this country than at any time since its shadow so malevolently fell across Europe. With so full a knowledge of the calamitous consequences of warfare as evidenced to us in the news from abroad, we cannot but pray that yet the threatening cloud may pass over and that we may escape the storm. Of no matter how short duration or how relatively unimportant a conflict we might be engaged in, the cost would be heavy to our industrial progress and it would be a great misfortune to have any setback at this otherwise auspicious moment for us to take the leading place in the commerce of the world. It should therefore be the most earnest wish of every thoughtful person that means may still be found for a peaceful settlement of the Mexican situation, if any can be had without the sacrifice of our national honor.

In the worst eventuality what will be the effect on the field of power-plant engineering? He would be bold indeed who would attempt to predict just what or how extensive would be the results, but a few things are certain to be expected. One of these is that all new work would be practically stopped. Capital would be withdrawn for the time at least from the promotion of any power developments. A considerable part of the constructing and operating labor would be called to the service of the flag. Many of the manufacturers of power-plant equipment would turn their works over to the production of munitions in line with the plans that are already fairly well laid out in the industrial-preparedness movement. Those at present engaged in munition manufacture under foreign contracts would be obliged to complete those contracts in all probability before they could begin to produce anything for this country. There would be no less a demand for power than at present and perhaps a greater one, but it would take time to adjust conditions to the needs. Distribution systems would be very materially affected, having in mind now the current supplies from the larger stations, for the centers of greatest load would be shifted. Transportation service would have to be almost completely reorganized, as the first call on the railroads would be for the handling of men and materials to the front, so that, even were the peaceful industries not affected in their production, they would be hampered for want of facilities to get their goods to the market and to obtain their supplies of raw materials. More than that, the supplies themselves would be diverted to other uses—coal, iron and steel and all metals and practically everything that goes into mechanical products would by right be taken first for the building of machines for warfare and the supplies to keep them in action.

New channels for the consumption of utilities as well as the very necessities of life would increase in cost so that every individual would feel the added expense, all of which would be aggravated by the taxation necessary to carry on a war. And nothing has yet been said of the economic waste that the country must suffer in the toll of lives sacrificed, nor is it the purpose here to dwell upon the hardships of the combatants, the anxiety of their relatives or the griefs of the bereft, which alone are more than enough to make war a thing to be avoided up to the last moment.

If war there must be, it is to be hoped that it may be very short, for the longer it lasts the slower will be the recovery from it and the restoration of normal conditions. At best it would be a dire calamity to this country at any time, and perhaps especially now. Nevertheless as a people second to none in national pride and patriotism, we must and do stand ready to face it if the necessity comes, whatever the consequencees.

The Identity of Authors

A contributor, who is evidently the subject of a struggle between modesty and other considerations, asks for an expression as to the desirability of the addition to his signature by an author of a mention of his official connection or the position which he occupies.

By all means such mention is desirable. The reader has a right to know who is talking, what his qualifications are to discuss his subject, what special opportunities, if any, his position affords for acquiring information upon it. The objection of employers, personal and other considerations often make it impracticable for a contributor to reveal even his identity, much less to announce his position, but no fear of being thought presumptuous should deter a writer from appending this information when it is possible to do so.

Governor Whitman of New York vetoed the Bewly bill, which would have authorized the adoption of the Boiler Code of the American Society of Mechanical Engineers, claiming that the labor department could legally adopt the Code, whereas adoption of the Code and its future amendments, without including all of it in the bill, would be delegating legislative power to the society. The governor thought the aim of the bill was meritorious. The veto was to be anticipated, though it would have been interesting to read debate on the constitutionality of such a bill. Readers will recollect that in the April fourth issue we cited several similar cases where Federal courts had declared such bills and acts constitutional.

The index to volume 43 (the first six months of 1916) will be ready shortly and will be sent to all whose names are on the index mailing list. Those subscribers who received the last index are on the list. Any others will be put on who wish to be. A post-card request is sufficient.

Correspondence

Water-Works and Water-Tube Types of Condensers

The comparisons which Mr. Bancel has drawn in the May 23 issue of *Power* between the water-works and water-tube types of condensers based on the writer's "Duty and Friction Loss Tests at Kirtland Station," published in *Power* of Dec. 14, 1915, and Feb. 8, 1916, are probably correct as far as they go, but the following points with which Mr. Bancel was not familiar throw quite a different light on these comparisons.

1. The installation of this unit at Kirtland Station is only temporary, and it was designed to pump against the 50-ft. higher head which will be maintained when it is moved to Division Station.

2. The condenser was designed to take care of a unit which would have a duty of 136.5 million foot-pounds per thousand pounds of steam instead of 152 million, which was obtained on test. Combining these two conditions, it is readily seen that on the acceptance test the condenser was condensing less than 75 per cent. as much steam as it was designed to take care of. This partly accounts for the low heat transmission on the test.

3. The friction loss through the condenser was practically two feet in excess of that which we had reason to expect, since the City of St. Louis has two 40-million gallon pumps equipped with similar water-works type condensers and the friction loss through these condensers amounts to only two feet. It is quite probable that the rather unusual piping arrangement which we put in for this temporary installation accounts for a considerable amount of this friction, since the water enters and leaves the condenser through 90-deg. elbows.

4. When this condenser is installed in its permanent location, a bypass will be piped around it so the quantity of water passing through the condenser can be reduced to any desired amount, and judging from the friction-loss curves published in the Feb. 8 issue of *Power*, this friction loss can be reduced to less than six inches of water, and no small direct-driven or auxiliary-driven pump can furnish the circulating water for the small additional amount of steam required to do this work.

5. This centrifugal unit is to be installed in a station with five triple-expansion crank-and-flywheel pumping engines which will carry the main load, since several of them have a duty of approximately 200 million foot-pounds per thousand pounds of steam. For this reason the turbine unit was designed for a vacuum of 28 in. and the value of $500 per million foot-pounds was placed on the duty, when, as a matter of fact, if the unit were to operate continuously this should be very nearly $2,000. We believe it is poor economy to pay a high price for a high-vacuum turbine, condenser and auxiliaries for intermittent service.

As far as the ability of the water-works type condenser to maintain high vacuums is concerned, I would like to call the attention of the readers of *Power* to the DeLaval installation at the City of Philadelphia, where their units are maintaining constantly a one-inch absolute vacuum and sometimes eight-tenths of an inch.

The arrangement suggested by Mr. Bancel of driving the circulating pump from the main unit was neither practicable nor desirable for our installation. The foundation for this unit is already 40 ft. long and only 11 ft. wide, and it would have been necessary to move part of the building to install a circulating pump on the end of the main pump shaft. Further, installing a circulating pump in this manner does not allow the quantity of water which it handles to be varied with the varying temperatures of the cooling water, so that just as much water would have to be pumped at a temperature of 32 deg. as at 76 deg., which is an unnecessary expenditure of power. A far better arrangement is that which we have at Division Station on the 100 million-gallon units. Here we drive the circulating and vacuum pump with steam bled from the 60-lb. stage of the main turbine and use the exhaust for heating the main turbine condensate. This allows the auxiliaries to be run with steam at an economical pressure, and no exhaust heat is wasted.

In conclusion, the fact that the water-tube condenser lends itself to better design, as far as steam and water velocities are concerned, is no proof that the water-work: type is obsolete, since under favorable conditions, it will maintain vacuums of one inch absolute or better with no circulating-pump investment or maintenance and a higher over-all efficiency of the unit.

L. A. QUAYLE,
Assistant Engineer of Power,
Cleveland, Ohio. Dept. of Public Utilities.

Replacing Scrapers on Renewed Economizer Tubes

In the articles on renewing economizer tubes (*Power*, Feb. 8, Mar. 14 and 21) none treated the subject of replacing the scrapers, which, if not done, would allow the soot to accumulate on the tubes and impair the heat transmission to the water.

On overhauling an economizer it was decided to replace 101 tubes that showed signs of leaking at 175 lb. pressure. Replacing the scrapers on the fourth and fifth tubes from the ends of ten tube sections, fitted with the old style (Green) bottom headers that do not permit the scrapers being passed up through them from the bottom is a tedious task, even when using a scraper-holding tool with an extension handle.

In using the holding tools, after the repair tube is in place and calked, to replace the scrapers it is necessary to separate the scraper-lifting bar from the guard, which may be corroded or otherwise in bad condition. Then care must be taken in getting the guards apart, or a new guard may have to be put in, in addition to eight or twelve sets of scrapers to be replaced instead of one set. The following is successful and eliminates the necessity of separating the lifting bar from the guard:

Get a set of scrapers ready by fastening around their shanks and about an inch above the lugs, a piece of iron

stove wire, leaving a free end of wire 8 or 10 in. long. Drop the end of a heavy cord down through the tube hole in the top header to the man stationed below with the scrapers, who will fasten the wire to them with a half-hitch at the shank below the upper cutting edge. The man above will pull the scraper up to within reach of his hand by putting his arm down through the tube hole, and while holding the weight of the scraper with the cord in his other hand, place the scraper lugs in their respective sockets between the lifting bar and guard. Fasten them with the free end of the wire to the bar and guard or to a neighboring scraper, whichever is most convenient. Care must be taken to have the upper cutting edges of the scrapers spread apart to permit the repair tube to be lowered more readily than if in their normal positions, which they will assume when the lower end of the tube has cleared the lower cutting edges of the scrapers.

The tube can then be driven and calked in the usual manner, with a mixture of sal ammoniac and iron filings or iron cement.

L. C. KRAMER.

Berlin, N. H.

Lubricator Pump Will Not Feed

An engineer in a cotton-mill power plant has been considerably annoyed by the failure of a double-plunger force-feed lubricator (the piping is shown in Fig. 1) to force oil to the valves after the engine has been shut

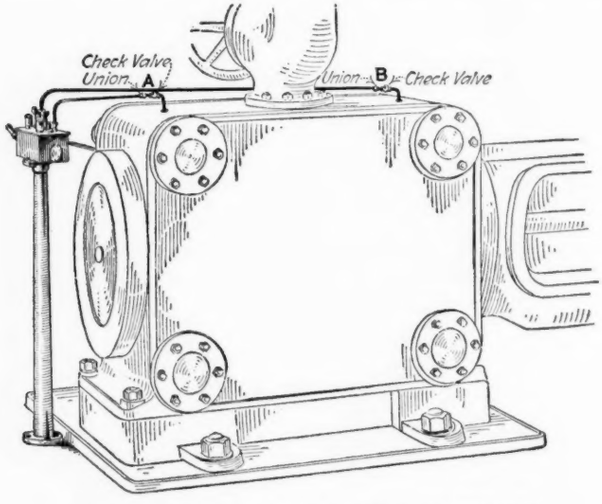


FIG. 1. PIPING OF LUBRICATOR TO ENGINE

down during the night. Frequently the pump does not force oil after the noon-hour stop. After breaking the union joint at *A* or *B*, the lubricator will feed properly. The short pipe gives as much trouble as the long one. A sectional view of the lubricator is shown in Fig. 2.

The engineer is at a loss to know why the lubricator will not force oil after the engine has been shut down for several hours. He thinks that the trouble is due to the ball check in the delivery pipe leaking more or less steam and that when the engine is stopped the steam collects in the small pipe connection and, condensing, forms a partial vacuum, which is destroyed when the union is broken. He does not believe that the design of the lubricator has anything to do with the trouble, but holds that the vacuum in the discharge pipes is sufficient to keep the ball checks from seating properly when the plungers are returning from their delivery stroke, thus resulting in a churning action that prevents oil being forced to the engine cylinder. He aims to empty the reservoir

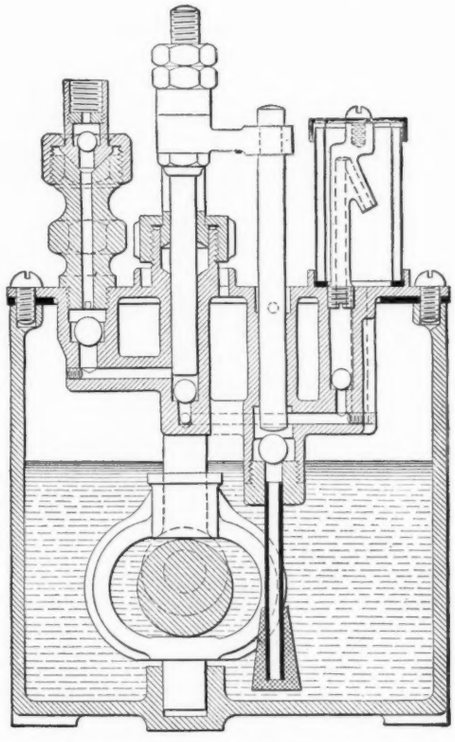


FIG. 2. INTERIOR CONSTRUCTION OF OIL PUMP

at the end of each day's run and fill it in the morning with hot oil.

Why should the lubricator act in the way it does? Why should two other makes in the same plant act in the same way? Does emptying the lubricator affect its operation? Is the engineer's diagnosis of the case correct, and if not, what is the trouble?

P. A. RALSTON.

Boston, Mass.

Evolution of a Steel Stack

The interesting photographs appearing in the issue of May 9 on page 657, showing the erection of a steel smoke-stack, raise the question: How many engineers know the way a stack is developed—the various steps through which it must pass before it may be called a stack?

There is a large amount of work attached to designing a smoke-stack. The first step is to determine the height and diameter, or bore, necessary to furnish the required draft and to prevent the cinders and smoke falling in close proximity to the station. When this has been done, the weight of metal may be estimated, from which the strength of the foundations upon which the stack must stand may be calculated. Then the strength is considered from the viewpoint of wind and other stresses.

At this stage of the work the first drawings are made. There will be in all three separate and complete sets of drawings. The first set outlines the engineer's calculations, the stress-strain diagrams and the minimum

strength of the various parts of the steelwork. From these the details of the stack are worked up into a second set of drawings showing the thicknesses and sizes and positions of each part, every bolt and rivet and plate. This set of drawings usually starts considerable discussion as to safety, cost, etc. However, when finally passed upon, the drawings go to the templet maker, who makes a replica of every part in cardboard, a working model as it were, to be sent to the steel mill, where the steel is sheared, punched, formed and otherwise prepared by the layer-off. If the stack is to be large, one or more inspectors are usually sent to the steel mill to watch the testing of every heat of steel both chemically and mechanically and for dimensions, location of holes, etc.; and when ready for painting, the inspector sees that this is properly done.

While the steel is being made ready at the mill, the draftsmen are busy making the third set of drawings, for the use of the engineers doing the erection, giving the location and size of every part. On large work the erector's drawings are often used by the inspectors at the mill, who see that the steel is shipped in the proper order so that it will not be necessary to handle a piece more than once, or more than as few times as possible from unloading to completion. Stiff-leg derricks, floating derrick and various tackles are put in place, including apparatus for heating and driving the rivets, and platforms are built. When the steelwork is finished, the brick lining is laid, and the grout which prevents corrosive action of the gases between the steel and the brick is poured, after which the stack is ready for its work.

Chicago, Ill. R. K. Long.

Another "Thinker" Poem

Some little time ago I read in your paper the poem about the man who works with his brains,[1] and am sending you the inclosed verses, which give a little of the experience of a thinker's wife. As this is only too true of the writer, I would not like you to publish my name, but simply Lu E., as I have given you in case you wish to make use of the verses.

My husband was quite amused with the rhyme and favors my sending it to you.

THE THINKER'S WIFE

I read with much pleasure and hold as a treasure
That poem of the fellow who thinks.
'Tis true to the letter, no mortal knows better
Than wife of a thinker, by jinks!

I've grown old and yellow with my thinking fellow,
Worn out in Economy's shop.
While genius is burning, there's little wage earning.
Enough of my troubles—I'll stop.

In that little story, which proves there's no glory
For thinkers beyond any doubt
(I'd like to make mention with all good intention),
The wife was forgotten—left out.

Don't think I'm for blaming my good man, I'm claiming
That each should receive what is due.
Though "decapitation and annihilation"
Are what the world gives, it is true.

These freaks, so ill-fated, should be compensated,
According to actual worth,
By state or by nation, for each wise creation,
But marry no woman on earth.

East Hampton, N. Y. Lu E.

[1] "Power," May 2, 1916, page 627. See also "The Thinker," Feb. 29, 1916, page 277, and "The Thinker Who Acts," April 11, 1916, page 497.

Results of Boiler Tests

In connection with the Boston Rubber Hose Co.'s boiler test, referred to in the issue of Jan. 6, page 26, Mr. Long has not supplied the readers with the details of his plant, the type of boilers, pressure carried, whether stokers and economizers are used, etc. These would have a bearing on his claim to the combined boiler- and furnace-efficiency championship.

I hope he will not shut the rest of us fellows out by insisting that his claim be based on the extraordinary results he obtained from the few tests that he reported, but will send us a detailed report from his records covering a period of, say, one year.

Almost any plant may give unusual short-time tests, but a championship should be based on a longer period, and a detailed report for the past year will give the rest of us something definite to shoot at.

Boston, Mass. Jos. L. Robinson.

Lubricants and Lubrication

In the issue of Mar. 7, page 318, in the fifth paragraph from the top of the page, Mr. Morgan in his article on "Lubricants and Lubrication" says adding graphite to oil will aid lubrication for a short time, but the pores of the iron soon become filled and it is impossible to keep any oil in the cylinders.

I would like to ask why the "but"? If the graphite enters the pores of the iron and perfects the metallic surfaces in such a manner that the function to be performed by the oil film is minimized and the quantity of oil used therefore greatly reduced, why is it not a good thing? J. C. Kinsley.

Chicago, Ill.

[The pores are commonly considered miniature reservoirs to contain oil and therefore beneficial, and as these pores become filled it is more difficult to keep oil on the surface of the cylinders.—Editor.]

Put It Over Naval Engineers(?)

In regard to an article which appeared in the Apr. 25 issue, entitled "Put It Over Naval Engineers," by John Wentworth, dealing with the installation of Diesel engines on floating cranes at Pearl Harbor, Hawaii, and Boston, Mass., I would like to comment as follows:

The writer of this article is apparently entirely unfamiliar with the Diesel engine at Pearl Harbor. In February, 1913, I installed this Busch-Sulzer Diesel engine and ran all my tests on a California asphaltum-base oil produced by the Standard Oil Co., called "Star Fuel Oil." This oil cost four cents a gallon here, and I remember that it was high in sulphur and about 18 deg. Baumé scale. During my test (running at three-fourths and full load) I averaged 6.75 gal. per 100 b.hp.-hr. I used 1,000 gal. of this oil in my test and had no trouble whatever, after which the engine was turned over to the Navy Department at Pearl Harbor. Since January, 1914, I have been using a gas oil that costs 3¾c. per gallon delivered in bulk here, and which was analyzed as follows: Flashing point, 140 deg. F. (open cup); gravity (Baumé), 32 deg.; sulphur, ½ of 1 per cent.; asphaltum, 2 per cent.; water and sediment, traces; calorific value, 19,400 B.t.u.

The engine has had practically no attention in 16 months; not a valve has been taken out, and on Mar. 29 I ran a test in which 95 gal. of oil was used to produce 952 kw.-hr., or 7.44 gal. per 100 hp.-hr. developed.

In regard to the belt-driven air compressor with storage air for starting engine, I have never been short of air, in fact, have never used more than the third bottle—six being supplied. However, I agree with the author of the article in that the air compressor should be motor-driven; but our reasons for this differ. I would make a separate installation to eliminate unbalanced effect on engine; he believes a separate motor-driven air compressor necessary merely to facilitate starting.

The engine at Boston is a duplicate of the one that I am operating, and there is no reason why it cannot be operated on the same oil that we use here, which, as stated, costs 3¾c. a gallon, against the 17c. that Mr. Wentworth says is being paid for the oil used in the Boston Diesel. If it is not giving satisfaction, it is not the fault of the builders or erectors. The blame, if any, lies with the naval engineers or men in charge of the engine.

I am not a Diesel-engine expert, but am thoroughly familiar with this type of engine. Neither am I a naval officer, but a civilian employee of the navy.

Honolulu, Hawaii. D. A. Buss.

Bought Lamps at a Bargain

Modern direct-current generators are designed to operate continuously at normal voltage and rated full-load current with a temperature rise not to exceed a specified amount above the temperature of the surrounding air. They usually will do this with a liberal margin of safety if the temperature of the surrounding air is within reason. The heating of an armature depends on the load current, as also does the heating of a series-field winding; the heating of the shunt-field winding, however, depends on the operating voltage.

The current output is what interests operators most acutely, and in striving to get maximum current output, ill-judged increase of voltage and consequent field heating are sometimes overlooked. Ordinarily the full operating voltage is not applied to the shunt winding, although it is applied to the shunt-field circuit, which includes the field rheostat. The voltage that is actually applied to the shunt-field winding is the difference between the operating voltage and the voltage drop across the field rheostat; and only when the field rheostat is entirely cut out is the field winding subjected to full voltage, and this should be unnecessary.

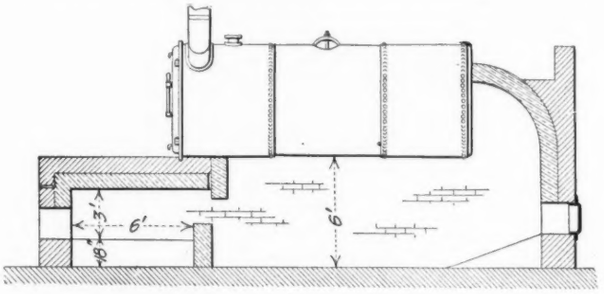
The supervisor of a small municipal plant complained that the field coils of his generator were heating more than they used to. Investigation showed that this was true, but that the heating was not dangerous. He formerly had operated the machine at 114 volts to supply 110-volt lamps. However, he had seized the opportunity to buy a lot of 118- to 122-volt lamps at a bargain and had installed many of them. In order to get satisfactory light from the more remote ones, it was necessary to operate the generator at 122 volts—all that it would give.

The unusual heating was due to the increased voltage that was applied to the field winding as the result of the field rheostat being entirely cut out to get the maximum possible line voltage. The attempted economy did no harm, but as the supply of bargain lamps began to give out, it kept the operator at the end of his wits to so place the renewals as to get satisfactory light from the 120-volt lamps without burning out the 110-volt lamps. His proposition was considerably eased by gradually reducing the voltage and by temporarily isolating a section of the service to be devoted to only the 110-volt lamps.

Schenectady, N. Y. E. C. Parham.

Evaporation Test with Shavings

The following gives the results of a test of a boiler with a special furnace burning nothing but shavings and bark—waste fuels. A sketch of the furnace is also given.



FURNACE FOR BURNING SHAVINGS

This boiler has 36 sq.ft. of flat grate surface, shaking grates, fired with shavings from 8:30 a.m. to 1 p.m., fired with spent tan from 1 p.m. to 4:30 p.m.

RETURN-TUBULAR BOILER

Duration of test, hr.	8
Steam pressure, gage, lb.	29
Temperature of feed water, deg. F.	122
Temperature of flue gas, deg. F.	675
Draft over fire, in.	0.8
Draft in uptake, in.	0.6
CO^2, per cent.	13.75
O, per cent.	6.17
CO, per cent.	0.74
Moisture in fuel, per cent.	59.12
Dry tan and shavings per lb.	1,387
Dry tan and shavings per sq.ft. grate surface per hr.	38.5
Boiler horsepower developed	135.7
Rated boiler horsepower	100
Equivalent evaporation per hr. per sq.ft. of heating surface, lb.	4.68
Water fed per pound of fuel as fired, lb.	1.37
Equivalent evaporation per pound of fuel as fired, lb.	1.38
Dry fuel per horsepower, lb.	10.02
Heating value of fuel as fired, B.t.u.	3,504
Heating value of dry fuel, B.t.u.	8,569
Efficiency of boiler furnace and grate, per cent.	50

Canton, N. C. H. Kilday.

Vacuum Gage on Suction Line

The utility of a vacuum gage on a suction line was brought to my attention recently. A pump had been overhauled, but failed to deliver its rated amount of water per stroke. A vacuum gage attached to the suction line registered 26 in. when the actual lift was only 10 ft. and the water temperature 40 deg. F. This proved the pump to be in good condition, but indicated a partly obstructed suction line.

Vacuum tables show that with water at 40 deg. F., a lift of 33 ft. is possible with a vacuum of 29.6 in.; so if a vacuum of 29.6 in. will lift water 33 ft., how many inches will be required to lift it 10 ft.? By the simple rule of three the larger vacuum (29.6 in.) is to the smaller vacuum (unknown) as the larger lift (33 ft.) is to the smaller lift (10 ft.), or $29.6 : x :: 33 : 10$. Multiplying the two extremes and dividing by the known mean gives the unknown mean, or $(29.6 \times 10) \div 33 = 8.97$ in. This proved to be the vacuum required after the end of the suction line was cleared or unstopped.

Somerville, Mass. Baldo E. A. Borenzi.

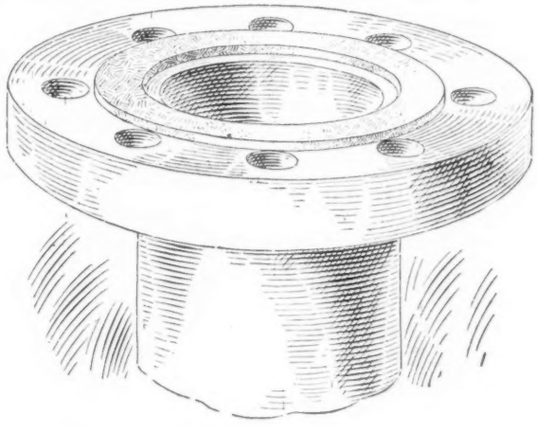
Renewing Blown-Out Gaskets

One of the disagreeable jobs in the power plant is that of replacing blown-out gaskets, but much trouble may be avoided by knowing just how to go at the job. A gasket properly installed will hold much longer than one applied indifferently; in fact, there are places where, only by exercising the greatest care, can they be put in to stay.

One of the worst and most common errors is that of cutting the gasket the full size of the flange and making holes for the bolts. This not only consumes time, but requires three times as much sheet rubber, and when completed, it is decidedly inferior to a gasket cut to fit just inside the bolt circle. That part outside the bolt circle will in no way prevent a leak. Any unnecessary packing placed between the flanges only prevents the useful part of the gasket from being properly compressed.

Another error, too commonly found, is that of oiling the gasket before putting it in place. Oil is rubber's worst enemy, and even without lubrication the gasket will blow out soon enough.

If the gasket is cut to fit inside the bolt circle it will be much easier to get in place, as the bolts on one side



PACKING CUT TO GO INSIDE BOLT CIRCLE

only need to be removed if the faces of the flanges are clean and the remaining ones loosened up about a quarter-inch, when the gasket can be slipped into place guided by the remaining bolts.

J. M. Row.

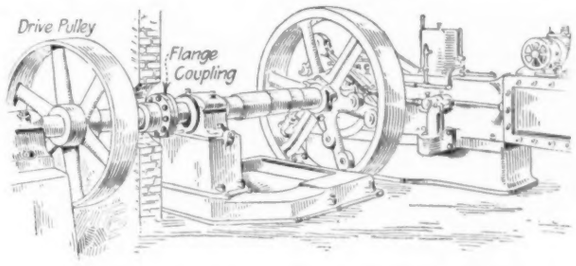
Wichita, Kansas.

Lining a Shaft by Its Flanges

Occasionally a peculiar problem arises that calls for special methods. The simple way out of a difficulty once experienced by me may be of interest to the readers of *Power*.

A new mill engine was set in the space occupied by the old one, with the engine shaft coupled to a shaft extending into the basement of the mill. The shaft also carried a belt wheel occupying the same position as the flywheel of the old engine. Through a small error in the new foundation, the new shaft did not align with the mill shaft, and to make matters worse the new flange coupling did not seat true. The use of a line or level was out of the question in the cramped space, and on starting up trouble soon appeared.

When the manager, erecting engineer, master mechanic and chief engineer got together, two plans were proposed. One was to strip the mill shaft of all belts, pulleys and bearing (a difficult job) and so fit and bolt the flange coupling that the end of the shaft would run true and in



SOME DIFFICULTIES OF THE LOCATION

that way locate the correct position for the bearing. The other was to remove the mill shaft entirely, rig up a turning tool in the wall, face off the flange on the engine shaft accurately, then replace the mill shaft and so locate the bearing that the flanges would be parallel.

The chief engineer objected to each of these methods, as they would cause unnecessary delay and expense, and suggested the following: Loosen the flange bolts enough to relieve the shafts from flange strain. Then with a thickness or feeler gage measure and note down the space between the flanges at four points. Rotate the shaft 90 deg. and make similar measurements until readings are secured in four positions. Calculations made from these readings will show how much the shaft is out of line and in what direction, also the thickness and position of the shims necessary to go between the flanges.

To one not familiar with calculations, a simple method may be used. Take two opposite points on the flange, then so adjust the outer bearing that the readings at these points remain the same at all positions of the shaft. Then with the flanges just touching at one place, shims may be fitted in to compensate for the flange that is out of true and the bolts may then be drawn up tight.

This plan worked very nicely and had the great advantage of leaving all belts in place and under their usual tension, thus allowing automatically for any spring in the shafts or supports.

The job required only about two hours and was so satisfactory that this description is passed along in the hope of helping others out of similar difficulties.

Medina, Ohio. B. E. Eckard.

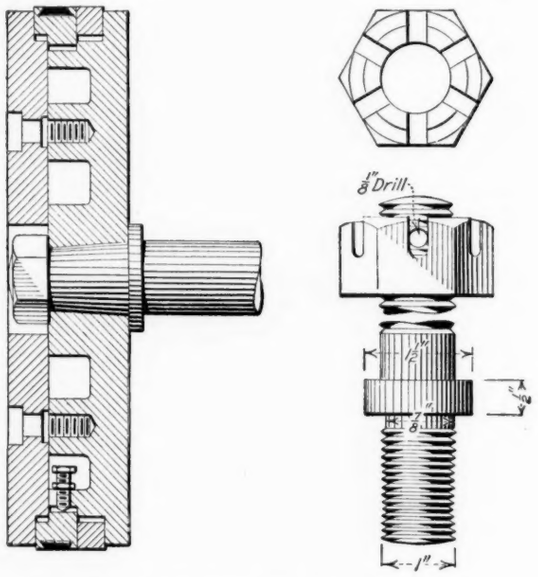
Design of Follower Studs

The built-up piston has some advantages over the solid type. It is light and has adjusting screws for keeping it central in the cylinder—a desirable feature in large engines. It has the disadvantage of being made up of several parts, and there is a greater danger of some of them breaking and possibly causing serious damage. Some of the principal causes of trouble are breaking follower studs, nuts working off or capscrews, when used, backing out of the spider.

I have had considerable trouble at times from these causes, and in some instances considerable damage was done, especially on a 20x36-in. Corliss engine. On two occasions the broken bolt went through the exhaust valves without doing serious damage. Another time the bolt

caught between the piston and cylinder head, and both were broken and the piston rod was bent.

When the new piston was put in, the studs were made as shown in the accompanying drawing. The shoulder on the stud prevents it from screwing out of the spider,



DETAILS OF FOLLOWER STUD DESIGN

and as the weakest part is back of the shoulder, if it breaks the broken part cannot get out. The follower plate is counterbored on the back to fit over the shoulder on the stud. The nut is made longer and slotted, sometimes called a "castle nut," and after being drawn up tight, a cotter pin is passed through the end of the stud. This prevents it from working off. When studs of this type are used, there is little chance of the parts doing any damage in event of breakage. However, if the stud does break back of the collar, it is necessary to drill the broken part out of the spider, and while this is not easy, it is preferable to running the chance of the broken bolt doing more serious damage. J. C. HAWKINS.

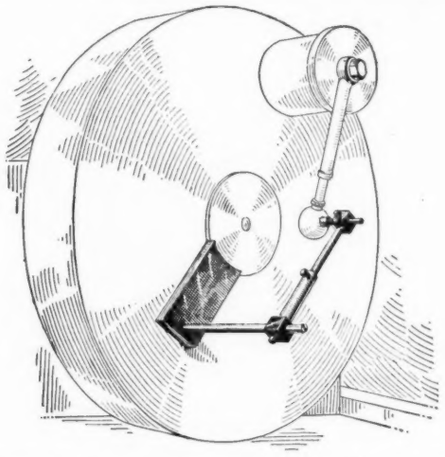
Hyattsville, Md.

Adjusting Centrifugal Oiler

The conditions under which some engines operate make it necessary to disconnect the connecting-rod frequently, and as the crankpins are oiled by centrifugal oilers, it is desirable to have a quick and reliable way to reassemble the oiling device and be sure it will run true, as it is often necessary to replace the connecting-rod in a hurry.

As a means of adjusting the hollow ball of the oiler central with the center of the shaft, a jig is used. It consists of a cast-iron base carefully machined and the arc made to fit on the crankshaft. A hole is drilled square with the base to support a post on which slides a hollow telescoping arm made with the outer end square and drilled to hold the stem of the cone. A setscrew in the square end of the arm allows of adjustment so that the base may seat squarely on the crank disk when the cone is inserted in the ball. The adjustable arm also assists, since the end of the shaft projects through the crank disk. The setscrew allows the arm to be secured at the proper height on the post to allow for the difference in the planes of the surface of the crank disk and the center of the ball when the jig is in use.

In using the jig the center of the ball is first adjusted with the center of the shaft by calipering, using a square. Then the cone of the jig is inserted into the ball, and with



DEVICE FOR CENTERING A CENTRIFUGAL OILER

the setscrews loose, the several parts are adjusted. Thereafter in centering the ball it is only necessary to use the jig as shown, care being taken to prevent springing of the parts when tightening the locknut, as this would throw the parts out of adjustment. P. E. MERRIAM.

Methuen, Mass.

Fire-Pump Reserve Boiler Feed

Having found set forth in *Power* many useful ideas that are time and trouble savers, contributed by brother engineers, it is my desire to do likewise. At the last plant where I worked, I was put on a night shift and the first night the pump feeding the three return-tubular boilers (of 300 hp.) refused to work properly. It would run very fast and almost shake itself out of place, and as there was no duplicate pump and the water was very low in the boilers, I sent a hurry call for the chief.

Fortunately he lived near-by and hurried over and started the big fire pump in the engine room, opened a valve on a small line running to the boiler-feed line and filled the boilers in a "jiffy." It was a new one on me, but afterward saved me many a shutdown. No matter how many auxiliary pumps there are, a fire pump has to be kept ready for use always and it seldom fails. I therefore consider connecting it to the boiler-feed line a good thing to do. W. P. HUMPHREY.

Acra, N. Y.

The Average Weight of Wrought Iron is 480 lb. per cu.ft., or a bar 1 in. square section and 3 ft. long (36 cu.in.) weighs 10 lb. Therefore, to find the sectional area of a bar of uniform size throughout its length regardless of its shape, multiply the weight per foot by 3 and divide by ten ($\frac{3}{10}$). Example: An I-beam 4 ft. long weighs 72 lb. What is its sectional area in square inches? $72 \div 4 = 18$ lb. per foot. $18 \times \frac{3}{10} = 5.4$ sq.in. sectional area.

A Glasgow Forfeit—In a specification recently issued for a 6,000-kw turbine by the Glasgow Corporation, the following clause was inserted: "Should the contractor fail to meet the guaranteed steam consumption, the contractor shall pay to the corporation the sum of £750 for every quarter of a pound or part of a quarter of a pound consumed over and above the figure of guaranteed steam consumption per kilowatt-hour."

Inquiries of General Interest

Right- or Left-Hand Engine—When is an engine called a right-hand or left-hand engine? F. W. H.

A side-crank engine is denominated "right hand or "left hand" according as the shaft extends to the right or left hand of the observer when he stands at the cylinder and faces the crank.

Hoop Tension of Boiler Shell—What is meant by hoop tension of the material of a boiler shell?

The term "hoop tension" applies to the stress of circumferential tension to which the material of a pressure vessel is subjected in offering resistance similar to that afforded by the hoop of a barrel.

Indicated Power Apparently Less Than Brake Power—In making a brake-indicator test of a small engine, where the instruments were carefully calibrated and computations and data were carefully checked, the results show greater brake than indicated power. What is the probable source of error? A. G.

The indicator diagrams that showed the discrepancies probably were taken at times when the speed was decreasing and all computations were made on the basis of uniformity of speed. Under such circumstances the inertia of the engine flywheel might relieve the piston of enough work to result in indication of less work performed in the cylinder than was apparently developed as brake power. Error of the kind might easily be introduced by hunting of the governor or employment of a brake that had a tendency to grab the brake wheel.

Weldless Boiler Braces—What different forms of weldless diagonal stays are used for boilers? R. N.

The three general types of weldless diagonal stays most commonly used are the Scully, the McGregor and the Huston.

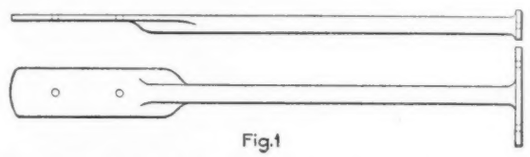


Fig.1

The Scully brace, shown in Fig. 1, is made from one piece of soft steel pressed to shape in a forging machine without welds.

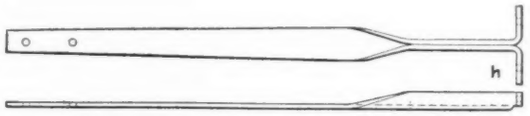


Fig.2

The McGregor brace, Fig. 2, is made of folded steel plate with the material at the head end h split and bent to a T-shape.

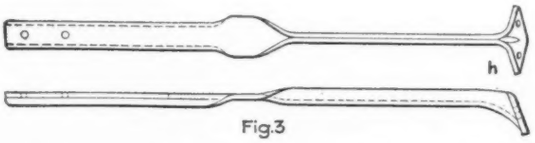


Fig.3

The Huston brace, Fig. 3, is made of folded weldless steel plate. The head end h is reinforced by fillets and the shell end is stiffened by raised ribs.

Asynchronous Generator—What is an asynchronous generator, and for what purpose is it used? B. A. N.

When an induction motor is running without load, the speed is slightly below synchronism. If power is applied to the rotor and it is run above synchronism, a current will be given back into the line. When operating this way it is called an asynchronous, or induction generator. This type of machine must be operated in parallel with an alternator or a circuit that is capable of supplying its magnetizing current. Asynchronous generators are not generally used, although some notable installations have been made where they were driven by low-pressure turbines run on the exhaust from reciprocating engines. In these cases generators of the synchronous type used on the reciprocating engines are connected permanently in parallel with the turbine-driven induction machines.

Steel Settings for Horizontal Return-Tubular Boilers—How are steel boiler settings for horizontal return-tubular boilers constructed, and what are their advantages over ordinary brick settings? C. R.

Steel boiler settings consist of an outer casing of sheet steel which is riveted together and stiffened with angle or tee iron, to serve the same purposes of supporting and inclosing a boiler as the common brickwork of ordinary settings. The steel casings are usually lined with a layer of asbestos covered with a layer of ordinary clay over which is placed a layer of fire-clay, or in some instances a firebrick lining is used with asbestos filling between the firebrick and the steel casing. The advantages of steel settings are that they may be made practically air-tight and are uninjured by expansion and contraction of the boiler or from settling of foundation walls and demand less skillful mason work for installation and repairs than is required for brick wall settings.

A Distinction Between Piston Clearance and Cylinder Clearance—If the stroke of an engine is 42 in. and the clearance at each end of the stroke is ¾ in., neglecting steam ports and passages, what is the percentage of clearance? C. E. W.

Piston clearance is not to be confused with cylinder clearance. Piston clearance signifies the distance the piston could be moved beyond the end of its stroke before it would strike against the head of the cylinder. Cylinder clearance is the term used to designate the volume of steam required to fill the space in the end of the cylinder and the ports and passages between the cylinder and valve seats when the piston is at the same end of its stroke. With 42-in. stroke and ¾-in. piston clearance at each end of the stroke, there would be $(\frac{3}{4} \times 100) \div 42 = 1.78$ per cent. piston clearance.

This, however, would not be the percentage of cylinder clearance even with the ports and passages neglected, unless the end of the cylinder had no counterbore or other space that would not be completely filled by the piston when it is moved up to the head of the cylinder. Any change made in the percentage of piston clearance results in the same percentage of increase or decrease of the cylinder clearance of the same end of the stroke, but in other respects piston clearance is no index of cylinder clearance.

Size of Conductors—What size of copper conductors is required to transmit 20 hp. at 220 volts, 1,800 ft., allowing 1 per cent. loss in the line, and what would be the drop when transmitting 40 hp.? F. W. C.

The current may be found by the formula,

$$I = \frac{Hp. \times 746}{E}$$

where

I = The current in amperes;
Hp. = The horse power transmitted;
E = Volts at source of energy.

Hence

$$I = \frac{20 \times 746}{220} = 68 \text{ amp. approx.}$$

The size of conductor is found by the formula,

$$\text{Circ.mils} = \frac{22DI}{Ed}$$

where

D = The length of conductor one way;
I = The current in amperes;
Ed = Allowable volt drop in the line.

Therefore the required cross-section $= \frac{22 \times 1{,}800 \times 68}{2.2}$, or 1,224,000 circ. mils.

The drop when transmitting 40 hp. will be double that when transmitting 20 hp.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Report of Station Operating Committee--III*

SYNOPSIS—The first two parts of this report printed in the June 13 and June 20 issues covered Boiler Operation and Water Treatment. This part deals with Extraction or Bleeder Turbines and the fourth part on Oil as Fuel will follow later.

Extraction, or Bleeder-Type, Turbines

In looking up the history of the steam turbine, it is interesting to note the great advance in the economy as well as the capacity of this type of prime mover. In 1905 in a report of a committee on the steam turbine, consisting of Messrs. Eglin, Dunham, Moultrop, Cato and Andrew, to the National Electric Light Association, held in New York City, they gave the number of turbines of the largest size in operation at that time as follows: Four 5,500-kw. machines, ten 5,000-kw. machines, with a total of all descriptions of 224 turbines with an aggregate capacity of 350,000 hp. In 1905 the largest turbine designed to operate noncondensing was of 2,000-kw. capacity running in a sugar refinery. The first large extraction-type turbine in operation was a 2,000-kw. unit in 1905. There are about 30 extraction-type turbines in operation at the present time.

Before considering the use of steam turbines for heating, drying or other purposes requiring exhaust steam, a careful survey of all the conditions from every viewpoint should be made. The electrical and heat balance should be carefully studied not only from the present aspect of the case, but also the future development of the electric and heat loads, to determine as far as possible the approximate divergence of the respective loads.

There is a point where a noncondensing unit would prove more economical, also a point where a condensing turbine should be installed and live steam used. As a general statement, an extraction turbine should be installed when it can carry the average load with the average amount of steam required for heating being extracted. Some of the limiting factors governing the maximum amount of steam to be rejected to the heating system are—the capacity of the turbine is reduced, the regulation is impaired, and the ability to handle momentary overloads is handicapped.

With an extraction turbine, as with a straight condensing turbine, the ability to handle overloads depends on the design of the unit. For instance, in a straight condensing machine, assume a water rate of 20 lb. per kw. on a 500-kw. machine. If the nozzles of the turbine were designed to pass only 10,000 lb. of steam, the machine would have no overload capacity, and if it is running at or near the full-load point, we cannot take much of a swing. In an extraction machine suppose it were designed to deliver 1,000-kw. load and a maximum of 30,000 lb. of steam—when giving this electrical load if we were extracting no steam we would have a great overload capacity on the electrical end, but if we were extracting 30,000 lb. and attempted to go above 30,000 lb. extraction we would have to relieve the turbine of some of the electrical load in order to have any overload capacity. In other words, it is merely designing the turbine liberally enough to carry the maximum load with a safe overload capacity on top of this. As the load on the turbine is the sum of the heating and electrical load, the heating load serving to take capacity off the machine the same as the electrical load does, it will act the same as any other equipment when overloaded on either end. The regulation should not be materially impaired unless we are running too close to the maximum on either the steam or electrical load.

We believe that the most common cause of dissatisfaction with the extraction-type machine is due to the fact that a man is unable to definitely determine the amount of steam he is taking to the heating system and in many cases will attempt to extract more steam than the machine was designed for and be disappointed because the machine will not deliver its full electrical load as well. In other words, while he can readily determine by the meters on the switchboard when he is getting to the limit of the capacity on the electric end, there are usually no similar instruments on the extraction line to determine when he is reaching the limit on the steam end, so that it is possible to have his machine running practically at the maximum-load point considering the total steam and electrical load and not be aware of it until some sudden demand on the electrical end exceeds the capacity of the unit and makes itself known by a decrease in speed with a consequent disturbance on the electrical system. It is found in practice that when a central station is furnishing power for large milling industries, etc., any variation in speed is immediately noticed in the operation and output of these mills. It is necessary, therefore, that sufficient generator capacity is in service at all times to provide for short-circuits on exterior lines or momentary overloads.

A point can be reached where live steam must be admitted to the heating system or another unit placed in service. It is usually more economical to admit some live steam than to place the extra unit in service. This depends on the relative load factors. The economy of a turbine of this type as given by the manufacturers is usually the over-all economy per kilowatt when extracting a certain amount of steam. But the actual percentage of the total heat admitted to the turbine used and the balance rejected to the heating system is not given.

Noncondensing turbines for heating purposes should be installed only when the average exhaust steam required equals or exceeds the electrical output of the unit. For hot-water heating a condensing unit designed to carry full load when running noncondensing has given satisfactory results. When properly installed, any required vacuum to maintain any necessary temperature can be obtained with a corresponding economy. In case of low steam due to boiler trouble, the turbine can be immediately operated condensing with maximum economy, thus protecting the electric load when otherwise both heating and electric loads might be lost. This point also applies to turbines of the extraction type.

On account of the extra boiler capacity required with noncondensing apparatus, it may be found that the extra fuel and maintenance required to bank fires during the nonheating season will pay the interest charges on the additional cost of the cheaper condensing system. And by using extraction or condensing turbines running noncondensing, depending on the amount of steam required for heating with relation to the size of turbine and its load, satisfactory results are attained.

In the design of a new plant complete, care should be used to arrange the system to be operated with as low a back pressure as possible, and the manufacturer of turbine apparatus should be fully acquainted with the pressures and amounts of steam required for heating. It might be that the extraction openings from the turbine could be taken from a point nearer the exhaust end of the machine by slightly lowering the pressure below that stated in the proposition as first placed before them. In other words, with an absolute stated pressure and load specified, it might compel them to extract the steam at a higher stage than necessary with lower economy. In this case a slight increase on investment in sizes of heating mains might be advisable, the increased economy of the unit serving to pay the additional interest charge in all the foregoing. (I am referring to plants having units of 500-kw. capacity and larger.)

ADVANTAGES OF EXTRACTOR TYPE TURBINES

The saving by using an extraction turbine is shown by a prominent turbine engineer by several examples which follow and prove conclusively the economy of this type of apparatus and also the economy of keeping the extraction pressures as low as possible: First, the problem is supplying 22,000,000 B.t.u. per hr. to the heating system and 1,000 kw. electrical energy. If we use a straight condensing turbine, it will be necessary to take steam direct from the boilers for the heating load, which would require for the amount of heat given, 18,400 lb. of steam per hour. The electrical load would require 18,500 lb. of steam (18.5 lb. per kw.), or a total of 36,900 lb. of steam for the combined load. If an extraction turbine was used and it was necessary to extract at 15 lb. gage pressure, the quality of the steam at the extraction opening of the turbine would be approximately 96½ per cent. dry, and it would then require 19,700 lb. of steam per hour to furnish 22,000,000 B.t.u. heat energy. The turbine would deliver this 19,700 lb. of steam at 15 lb. gage back pressure and 1,000 kw. electrical energy for a total of 31,600 lb. of steam at the throttle, or a saving of 36,900 minus

*Presented at the eighth annual convention of the National District Heating Association, New York City, May, 1916.

31,600, or 5,300 lb. of steam per hour. Without the extraction turbine it would, as stated, require 18,400 lb. of steam per hour for the heating system. Therefore, the amount of steam chargeable for power would be 31,600 lb. minus 18,400 (the equivalent of which goes to the heating system), leaving a balance of 13,200 lb., being at the rate of 13.2 lb. per kw.-hr. chargeable to power. If we extract at 5 lb. pressure (quality 95.5 per cent.) owing to the slightly lower heat content, it would require 20,000 lb. of steam to furnish the 22,000,000 B.t.u. heat. Under this condition the turbine would deliver the 20,000 lb. of steam at 5 lb. pressure and deliver 1,000 kw. electrical load for a total of 28,900 lb. of steam at the throttle; 28,900 lb. minus 18,400 lb. (chargeable to heat) leaves a balance of 10,500 lb. chargeable to power, or 10.5 lb. per kw.-hr.

It will be observed from the foregoing calculations that all the saving is credited to the electrical department. As a matter of interest, it should be noted in passing that this saving does not all accrue to the electrical department—in fact, it is questionable which department, steam or electric, should get the credit, or whether it should be divided between the two. One thing is certain—if an existing electric plant adds to its system a heating plant, this saving would be credited as an advantage to having a heating plant. If for matter of rates the cost of service in the two departments was to be considered, then this saving should be divided between the two departments somewhere in proportion to the steam requirements of each.

Under the foregoing figures (extracting steam at 15 lb. pressure) the saving of 5,300 lb. of steam should be divided between the heating and electrical operating costs in proportion to the steam requirements if each were operated separately. Of this saving $^{197}/_{369}$ would be allowed to the heating department and $^{172}/_{369}$ would be credited to the electrical department. In this paper this matter has not been considered. We have endeavored only to show the saving and what it was, without consideration of what department would be affected.

It is evident from these calculations that extraction of steam from a turbine at 5 lb. back pressure for heating, has a decided advantage over extraction at 15 lb. back pressure, in (1) 3.5 per cent. more lb. of steam extracted into the heating system; (2) 25.2 per cent. decrease in the cost of producing 1,000 kw. Again, in the extraction against a back pressure of 15 lb., we have 6,600 lb. of steam that was used in producing part of the 1,000 kw. and again used in the heating system. And in the extraction against a back pressure of 5 lb. we have 9,600 lb. of steam that was used in producing part of the 1,000 kw. and again used in the heating system. Or an increase of the 5 lb. over the 15 lb. of 6,600 ÷ 9,600 equals 69; 100 — 69 = 31 per cent.; that is, 31 per cent. more steam is saved by extracting at a back pressure of 5 lb. than 15 lb.

MINIMUM BACK PRESSURE SHOULD BE USED

We believe that the relative saving by operating under the lowest pressures is not thoroughly appreciated and that cases of improper installations and piping that impose a burden on any existing plant in increasing pressure to furnish satisfactory service to these isolated cases should be either corrected or eliminated entirely from the system. New business departments sometimes in their zeal to make a good showing, which of course is commendable, forget the advisability of taking on certain loads from an engineering standpoint. While diverting from the point under discussion, the writer cannot refrain from stating that the closer the relations are between the sales department and the engineering department, the better are the final results.

So far as the operation of this type of turbine is concerned, we can only say again that all piping must be of ample size for the increased amount of steam required, oil pumps and governing apparatus large enough to handle the additional regulating mechanisms, back pressure or check valves of sturdy design, properly tested at stated intervals and kept in operative condition, especially when two or more units are in parallel. Also, when operating turbines in parallel with the exhaust from a reciprocating engine, the piping and regulating apparatus must be carefully arranged to avoid the pulsation from the exhaust which might start hunting in the turbine.

We believe more care should be given in the design of extraction turbines in the distribution of metal due to extraordinary temperature and expansion strains, and that all valves and connections add to the difficulty of maintaining a vacuum with light loads when operating straight condensing. A point in favor of extraction turbines is the effect on the average load factor on the boiler plant. Experience has shown that sudden overlapping peak loads can be taken care of by simply changing the adjustment of the extraction valves, allowing more steam to be used condensing for a few minutes, saving the standby boiler losses in some cases.

The use of extraction turbines, as compared with reciprocating engines for heating eliminates many sources of complaint and trouble. Experience shows that air vents require less attention, traps require less cleaning and meters are more accurate, owing to the absence of oil in the steam. There is less odor from air vents. Variators and valves require less attention. There is less moisture in the steam, owing to absence of initial cylinder condensation. Diaphragm breakage due to filling up of lower parts of variators with caking oil and dirt has ceased entirely.

Radiation is more efficient because of the absence of oil, and the care and attention of oil separators, traps, etc., at the power house is not required. In a system having over 500,000 sq.ft. of steam radiation, with about 400 consumers, this system being about 20 years old, all leaks, meter readings and troubles are taken care of by two men. This includes tests for pressures and other work foreign to legitimate maintenance and operation. The cost of cleaning apparatus decreased each year after the extraction turbine superseded the reciprocating units for heating. There have been no complaints traced to stoppage in pipes and fittings during the last year, and the steam is available in cooking processes in which the steam comes in direct contact with the material to be treated.

Labor costs at the power plant are less, as there is no oiling of engines and not so many parts to watch. A plant turning out from 900,000 to 110,000 kw. per day with 300 mi. of high-tension lines, 60 mi. of interurban railway and 500,000 sq.ft. of heating is operated with one watch engineer and one oiler per shift in the engine room.

Water-Works Plants

In a paper entitled "Difficulties in the Designing and Operation of Medium-Sized Water-Works Plants," presented by E. B. Black at the thirty-sixth annual convention of the American Water-Works Association, the author states:

The design and operation of systems in towns of small size present difficulties foreign to the design and operation of large plants. In designing, the services of an engineer are often dispensed with, and practically never is an engineer retained to advise relative to the operation of the system. This may be on account of the size of the proposition and the desire to put every dollar available into the improvement. Then again, the design may be handled by a concern manufacturing or selling equipment. Admitting the fact that such concerns may have the best engineering talent available, it is not reasonable to assume that other concerns will feel free to bid on their competitor's design, or that the proposal of the designer, if accepted without competition, will be either an efficient or economical one. Many small systems have been built by the contracting engineer. The design and the construction both frequently suffer in such cases. It is difficult for a man to design a system, bid on it with other bidders, and then construct under his own plans, specifications and supervision.

In some systems the poor ideas of the owner or city officials are followed; this is sometimes the case even when an engineer is retained.

In the power plant, that part of the system where efficiency might be expected, and in plants where tests are made on the equipment at the time of its installation, provision is seldom made so the superintendent can run an over-all efficiency test at any time, and the guaranteed efficiencies under which simple equipment is often purchased are frequently impossible of determination by the superintendent, after the plant has been turned over to him. Power plants are installed with separate guarantees on engines, boilers and generators; motor-driven pumps with separate guarantees on motors and pumps. In the small plant and in many large ones, an overall efficiency guarantee is possible, and it is the only guarantee for which the superintendent has a great deal of use.

Efficient equipment in a plant counts for little unless you know that that equipment is maintaining its efficiency through efficient operation.

The man never lived who thoroughly enjoyed writing reports and weighing coal, but no plant can operate successfully and economically without an accurate and detailed record of its operation. In the small plant, recording instruments and labor-saving devices, or even proper valves and meters, are sometimes entirely lacking. How can an operator know what his plant is doing when he only knows how much coal he uses and how much money he takes in each month? Nearly all owners object to the size of the coal bill or to the amount paid out for chemicals for the filtration plant, but very few offer their superintendents expert assistance in cutting down the size of these bills. Business management does not entirely consist in keeping the operating cost within the receipts.

The Proper Ratio of Economy Coils*

By Walter J. Kline

With reference to economy coils, there are but two kinds of heating systems: Those in which the temperature of the returns is inherently low, say 100 deg. F. or less; those in which the condensation is more than the minimum allowable, or in most cases up to approximately 212 deg. F.

It is the second division to which the question of economy coils applies and depends in all cases on the cost and continued annual saving. The use of a "ratio" when establishing the correct amount of economy coil for a particular condition is merely a "short cut" and is accurate enough for practical purposes. A theoretical determination simply involves a consideration of the latent and sensible heat of a given quantity of steam.

A pound of steam at 0 lb. abs. pressure, for illustration, has the following properties: 212 deg. F. temperature; 970.4 B.t.u. latent heat (Marks & Davis); 180 B.t.u. sensible heat, or the heat in the water. It is obvious that the exact ratio will be found, by separately calculating the radiating surface necessary to transmit the latent heat and then estimating the economy-coil surface necessary to conserve or extract the sensible heat in the condensate.

The coefficient of transmission for cast-iron radiators is somewhat variable. In Carpenter's "Heating and Ventilating of Buildings," it is stated that 1.8 B.t.u. per hour per degree difference of temperature is an allowable figure to use. Wherefore, if we assume an inside temperature of 70 deg., then the difference is 212 deg. — 70 deg. = 142 deg.; and the total B.t.u. per sq.ft. of direct steam-radiation surface per hour is 1.8 B.t.u. × 142 = 255.6 and $\frac{970.4}{255.6}$ = 3.7965 sq.ft. of surface required to radiate the latent heat in one pound of steam in one hour.

In determining the relative amount of economy coils, certain assumptions must be made: Assume room temperature 70 deg. F., outside air supply 0 deg. F. heated to 70 deg. The limit of effective cooling of condensation is the room temperature, 70 deg. While this is not practically attainable, it will serve as the basis of calculation.

Then $\frac{70}{2}$ = 35 deg. is the average temperature of the air supply and 212 — 70 = 142 deg. F. is the total temperature reduction; 212 — $\left(\frac{212 - 70}{2}\right)$ = 141 deg. F. is the average temperature of condensation, and 141 — 35 = 106 deg. F. is the average difference in temperature; then 1.8 (Carpenter) × 106 = 190.8 B.t.u. is the transmission per square foot of coil surface per hour; therefore $\frac{142}{190.8}$ = 0.744 sq.ft. is the economy-coil surface required to radiate the sensible heat available hourly in the condensate of one pound of steam.

Having determined the necessary coil surface (0.744 sq.ft.) and the necessary steam radiation surface (3.7965 sq.ft.), the ratio is 0.744 ÷ 3.7965 = 19.60 per cent., or practically 1 sq.ft. of economy-coil surface for each 5 sq.ft. of direct steam surface. This is the correct relation for new piping, although for safety a larger percentage is frequently installed.

Economy coils to be effective should have ample radiating surface and be properly installed, as few are—that is, properly inclosed and with housing or boxing either of matched lumber lined with bright tin or of galvanized iron properly insulated. The sides of the housing must have "stops" so that air must pass between the coils and not around the sides.

The housing must be closed at the bottom and have a cold-air inlet duct which extends about to its center. The top of the housing should pitch from the corners to the warm-air outlet duct. The housing should be constructed so that access to the interior is convenient. The inlet duct should have a damper to regulate the air supply according to weather conditions and to shut off entirely to prevent freezing of the coil when steam is shut off.

The heated air is conveyed to a floor or wall register at some point where heat is required constantly. The wall register is more sanitary and therefore preferable.

The cold-air inlet duct should have an area equal to 1¼ sq.in. per sq.ft. of coil surface and the warm-air register 1½ sq.in. per sq.ft. of coil surface.

The value of economy coils must be measured by the dollars saved compared with the cost of installation, and costs will vary somewhat with the locality and conditions, but should not exceed 50c. per sq.ft. of coil complete.

*A paper on the "Proper Ratio of Economy Coils for Different Kinds of Heating Systems," presented at the eighth annual convention of the National District Heating Association, New York City.

The all-important object is to reduce the total cost of heating. If, for example, the limit of 70 deg. is the lowest temperature to which the condensate will be reduced from 212 deg., each pound of steam contains 142 B.t.u. which may be saved. The quantity of steam condensed annually by 1 sq.ft. of radiation is an extremely variable quantity, but 500 lb. per sq.ft. may be fairly assumed as average results.

Upon this basis the heat transmitted by 1 sq.ft. of coil per season will be 970.4 × 500 = 485,200 B.t.u., as the total quantity of heat required for heating; and if all the heat in the condensate (142 B.t.u.) is utilized, the total available is 142 × 500 = 71,000 B.t.u., or $\frac{71,000}{485,200}$ = 14.6 per cent. of the total required. Therefore the total heat utilized from each pound of steam will be 970.4 + 142 = 1,112.4 instead of 970.4 B.t.u.

The actual steam needed, then, will be

$$\frac{485,200 \text{ B.t.u. (total needed)}}{1,112.4 \text{ B.t.u. (utilized per lb.)}} = 436 \text{ lb.}$$

of steam if economy coils are used; 500 lb. — 436 lb. = 64 lb. saved per square foot of steam radiation.

Then as 1 sq.ft. of economy coil operates in connection with 5 sq.ft. of steam radiation, each square foot of coil will be the means of saving 64 lb. × 5 = 320 lb. of steam, which, valued at 50c. per 1,000 lb., is

$$\frac{\$0.50 \times 320}{1,000} = \$0.16$$

This is equal to $\frac{\$0.16 \text{ (saving by 1 sq.ft. coil)}}{\$0.50 \text{ (cost of 1 sq.ft. coil)}}$ = 32 per cent. interest on the investment in economy coils.

Temp. Trap Discharge, Deg.	Temp. Econ. Coil Discharge, Deg.	B.t.u. Saved per Lb.	B.t.u. Utilized per Lb., 970.4 + C.	Per Cent. Saved of Total Required, $\frac{C}{970.4}$	Pounds Steam Required per Sq.Ft. $\frac{970.4 \times 500}{D}$	Pounds Saved per Sq.Ft. Radiation	Total Lb. Saved by 1 Sq.Ft. Coil C + 5	Value at 50c. per M Lb.	Per Cent. Profit on Investment in Coils
212	212	0	970.4	0	500	0	0	0	0
212	150	62	1,032.4	6.37	470	30	150	$0.07½	15
212	140	72	1,042.4	7.41	465	35	175	.08⅜	17
212	130	82	1,052.4	8.45	461	39	195	.09¾	19
212	120	92	1,062.4	9.48	456	44	220	.11	22
212	110	102	1,072.4	10.51	452	48	240	.12	24
212	100	112	1,082.4	11.54	448	52	260	.13	26
212	90	122	1,092.4	12.57	444	56	280	.14	28
212	80	132	1,102.4	13.60	440	60	300	.15	30
212	70	142	1,112.4	14.60	436	64	320	.16	32

In the table the values are worked out for various degrees of cooling, with steam at 50c. per 1,000 lb. and the assumed annual constant of 500 lb. per sq.ft. Other values of steam per 1,000 lb. and other annual rates per square foot of steam radiation may be readily substituted, if desired.

DISCUSSION

C. S. Barnes, of Boston, Mass., called attention to the following formula, which he displayed upon the blackboard:

$$\frac{I}{C} \times 1{,}000r \times \frac{1}{h \times d \times b \times c} = T$$

$$\frac{(Tw_1 - Ta_2) + (Tw_2 - Ta_1)}{2} \times b \over (Tw_1 - Tw_2) \times L = R$$

I = Yearly charge per square foot of economizer coil;
C = Cost per 1,000 lb. of steam;
r = Heat (B.t.u.) radiated per pound of steam by direct radiation;
h = Hours per day of heating;
d = Days per year of heating;
b = B.t.u. per degree per square foot per hour;
c = Relative value of heat supplied economizer coils as compared to heat supplied by radiation it replaces;
T = Minimum that average difference in temperature between any part of economizer coil and air passing it should be;
Ta_1 = Average temperature of entering air;
Ta_2 = Average temperature of exit air;
Tw_1 = Temperature of entering water;
Tw_2 = Temperature of exit water;
L = Lb. of water condensed per square foot per hour by direct radiation;
R = Ratio of direct to economy coil.

Mr. Kline replied, referring to Mr. Barnes' formula (on the blackboard): "I recognize this as being much more flexible than the ratio which I arrived at, though I felt that the result reached was the practical one, but the use of a formula taking into account all the various factors is by far preferable."

Refrigeration Plant Regulations New York and Detroit

In 1915 the Board of Aldermen of New York City passed an ordinance authorizing the Bureau of Fire Prevention to draw up and enforce regulations governing the use of chemicals used in refrigeration plants. The American Society of Refrigerating Engineers committee coöperated. This committee was made up of the following members as given in the "Journal" of that society: Louis K. Doelling, chairman, New York, N. Y.; Charles W. Berry, Boston, Mass.; S. B. Carpenter, New Brunswick, N. J.; H. Dannenbaum, Philadelphia, Penn.; F. L. Fairbanks, Boston, Mass.; George A. Horne, New York, N. Y.; L. Howard Jenks, New York, N. Y.; Edward F. Miller, Boston, Mass.; W. Everett Parsons, New York, N. Y.; John E. Starr, New York, N. Y.; Henry Torrance, New York, N. Y.; Llewellyn Williams, Boston.

Before these rules were adopted, operating engineers about the city offered criticism, and it is likely that now that they are applied, more criticism will be forthcoming. The rules are new, and it is to be expected that favorable amendments will result from justified and well-directed criticism. The rules follow:

EMERGENCY DEVICE

1. All refrigerating plants of three tons' refrigerating capacity or over, using ammonia or ethyl chloride as a refrigerating agent, shall be equipped with a device or devices for discharging the refrigerating agent under pressure, in case of emergency, into sufficient water to absorb all discharged gas and carry it off to the sewer. The device or devices to be constructed to conform with that recommended by the American Society of Refrigerating Engineers, Mar. 20, 1916, as shown on Fire Department drawing.

The Fire Department will have sole use of this device and supply the necessary water.

2. No valves shall be located in the emergency discharge lines except the control and check valves to the water and refrigerant mixer, but there may be one control valve on each emergency line located near connection to main high- and low-pressure lines for repair purposes only. Such additional valves shall be kept open at all times, and if closed will constitute a violation of the intention of these regulations.

3. The emergency valves and standard Fire Department Siamese connection shall be located on the public thoroughfare side of the building, either outside the building or in a vestibule having glass panel doors which will provide easy access from the street, with valves at a height of not more than five feet above street or vestibule-floor level. In no case shall the emergency valves be located over the exhaust outlet for ventilating the room containing the refrigerating plant.

In large refrigerating plants, at the discretion of the engineer in charge, there may be installed pressure gages on the high and low emergency lines for determining changes in pressure while emergency lines are operating.

4. The emergency valves shall be protected by a suitable box and kept locked. The lock shall be opened only by a "Fire Department Inner Box Key" and only by members of the Fire Department. On the outside of the box there shall be painted in easily legible letters the words "For Fire Department Use Only." The high-pressure emergency valves shall be labeled "High-Pressure Ammonia" and the low-pressure emergency valves shall be labeled "Low-Pressure Ammonia." A sign reading as follows shall be posted in the box: "Do Not Open Valves Until Water Is Flowing. Maintain 50 lb. Pressure."

AUTOMATIC SAFETY VALVES

5. All refrigerating plants of three tons' refrigerating capacity or over shall be equipped with an automatic safety valve or valves on each compressor or generator, which discharge at not greater than 300 lb. pressure per square inch for ammonia, 1,400 lb. pressure per square inch for carbon dioxide, 100 lb. pressure per square inch for sulphur dioxide or ethyl chloride. Such automatic safety valve or valves shall be connected to the "High Pressure Side," and may discharge to the "Low Pressure Side," as recommended by the American Society of Refrigerating Engineers, Mar. 30, 1916, and shown on Fire Department Drawing A.

The discharge from the automatic safety valve or valves may be conducted by continuous piping to a point at least 10 ft. above the highest opening in the roof of the building in which the plant is located. Point of discharge above the roof to be located as remote as practicable from horizontal openings in surrounding buildings. Where ammonia is the refrigerating agent, the discharge end of the pipes shall be equipped with a diffuser designed to mix the gas with the air without restricting its flow.

6. On carbon-dioxide plants, in addition to the heretofore-mentioned automatic safety valve at the compressor, there may be an automatic safety valve located on the high-pressure and on the low-pressure sides, as a substitute for the emergency device shown on the Fire Department Drawing A. The points of connection for such automatic safety valves shall be located as indicated for the emergency discharge lines. The outlet from such automatic safety valves may discharge into the engine room or to the outer air.

7. Pressure.

MAXIMUM PRESSURE ALLOWED

Refrigerating Agent:	Pressure
Ammonia	Not to exceed 300 lb. per sq.in.
Carbon dioxide	Not to exceed 1,400 lb. per sq.in.
Sulphur dioxide	Not to exceed 100 lb. per sq.in.
Ethyl chloride	Not to exceed 100 lb. per sq.in.

8. All pipes used for refrigerating purposes shall stand a hydrostatic test of at least double the maximum pressure per square inch specified in Sec. 7, and all fittings shall be guaranteed to stand a pressure of at least three times the maximum pressure per square inch specified in Sec. 7. All gage-glasses shall be adequately protected and provided with shutoff valves.

DEFINITION OF REFRIGERATING-MACHINERY ROOMS

9. Refrigerating-machinery rooms are rooms in which are located compressors, generators, condensers, receivers, absorbers or other apparatus necessary to produce or contain the refrigerating agent. Rooms which contain only the refrigerating chemical supply pipes to and from the refrigerating coils are not considered refrigerating-machinery rooms, but such rooms, if occupied by any persons, must comply with the requirements as to exits hereinafter described for refrigerating-machinery rooms.

LIGHTS, FLAMES, BOILERS

10. In all refrigerating-machinery rooms in which ammonia or ethyl chloride is used, there shall be no flames, arc lights, gas jets or any apparatus employing flame, except internal-combustion engines with internal ignition, which may be started in the usual manner.

11. All refrigerating-machinery rooms shall be separated from other parts of the building by tight partitions and tight self-closing doors, and from boilers by tight fireproof walls, unpierced except by openings protected by tight self-closing fireproof doors or stationary fireproof windows.

EXIT AND VENTILATION

12. All refrigerating-machinery rooms shall have a direct exit to the open air or to a room or hall from which gases can be excluded by self-closing doors.

13. Vertical and horizontal openings that permit the passage of gases to other parts of the building, which are not a part of the refrigerating plant, shall be sealed or provided with self-closing doors.

14. All refrigerating rooms shall be provided with adequate ventilation to the open air, either direct or by means of a suitable duct or ducts. Where a mechanical system of ventilation is employed, control of the system shall be located at a point easily accessible.

PLANS REQUIRED

15. All pipes containing a refrigerating chemical under pressure shall have conspicuous signs attached to them at proper places designating in easily legible letters the name of the chemical contained therein.

The signs shall be placed on each main-supply and suction pipe in each room. Valves which control main sections of

refrigerating system and are necessary to separate such sections in case of emergency shall be labeled.

RULES

17. In all refrigerating plants there shall be posted several copies of a brief set of rules, satisfactory to the fire commissioner, directing all employees as to their duties in case of fire or other emergencies.

Employers shall be responsible for the proper drill of all employees in such emergency duties.

HELMETS

18. All large refrigerating plants shall be provided with helmets of approved type, which will permit the wearer to reach, without suffocation, any part of the refrigerating system.

In plants of 25 to 75 tons' refrigerating capacity there shall be at least one approved helmet, and in plants of greater capacity than 75 tons there shall be at least two approved helmets.

19. These helmets shall be kept in a suitable case or cabinet of easy access, preferably outside of refrigerating-machinery room or near doorway leading therefrom.

SURPLUS REFRIGERATING STORAGE

20. Refrigerating plants may store a surplus stock of the refrigerating chemical of two cylinders, or, if necessary, a quantity not to exceed 10 per cent. of the charge of the plant. This surplus chemical shall be stored in a cool place.

CERTIFICATE OF FITNESS

21. No refrigerating plant of over three tons' refrigerating capacity shall be operated unless under the charge of a person holding a certificate of fitness from the fire commissioner, or who has been duly certified as competent to operate a refrigerating plant by any department of the City of New York having jurisdiction to certify thereto.

A certificate of fitness will be required of each person who is directly in charge of the operation of the refrigerating machines during each shift.

REFRIGERATING PLANTS OF LESS THAN THREE TONS' CAPACITY

22. The fire commissioner may exempt from the provisions of these regulations, except the provisions referring to flames and exits, refrigerating machines of less than three tons' capacity, provided a certificate of approval has been issued for such machine.

PERMITS

23. It is unlawful to operate within the City of New York any plant producing refrigeration by means of gases under pressure in connection with cold-storage plants, breweries, ice manufactories, restaurants or other places, without a permit.

The application for permit must state the refrigerating builders' rated capacity in tons, the kind of chemical used, the amount of surplus chemical stored, the number of shifts and time the plant is operated during a period of 24 hr.

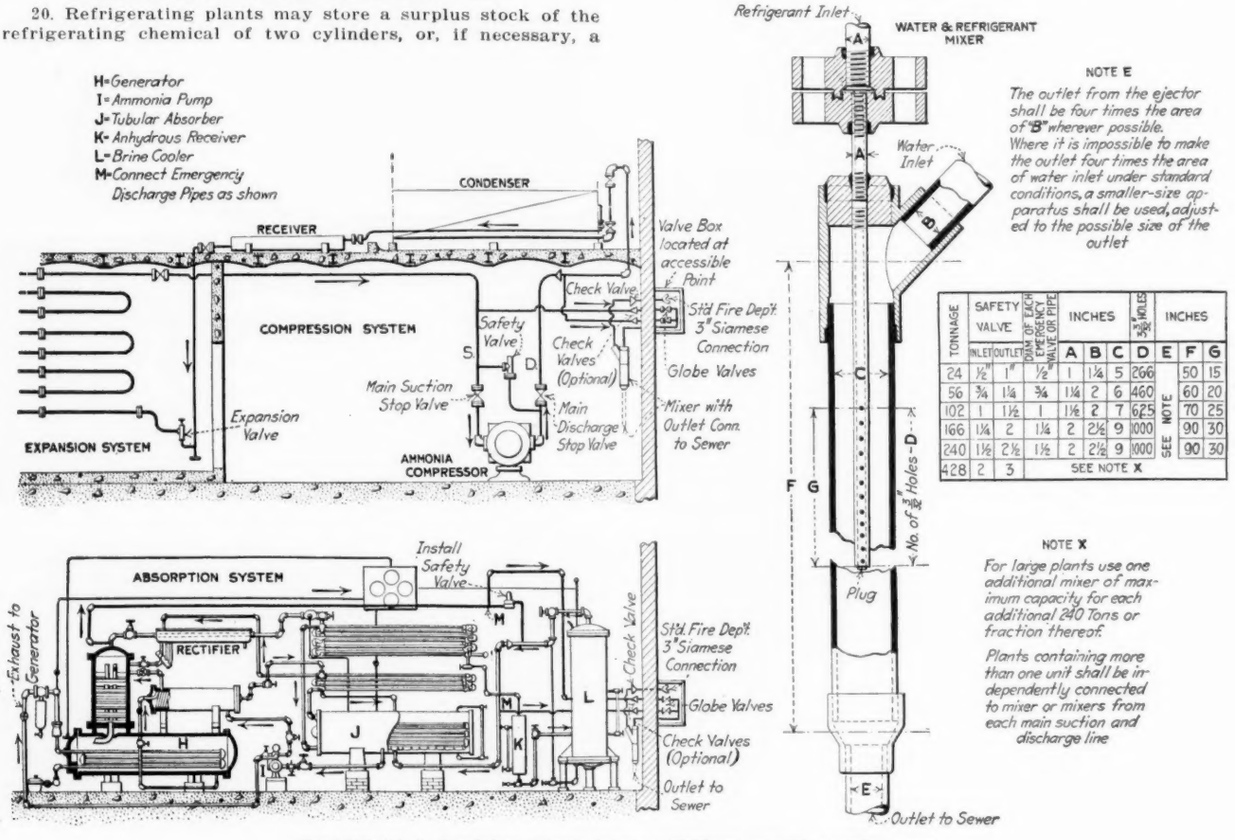
The application shall be signed by the applicant or authorized agent and give the name and address of the applicant and the address where the plant is located.

The Detroit Refrigeration Regulations

The refrigeration plant regulations now in force in Detroit are as follows:

Section 1 (Inspection)—It shall be the duty of the chief of the Department of Safety Engineering and his assistants, in addition to their other duties, to inspect all manufacturing houses, ice-making houses, cooling plants, refrigerators, packing houses, cold-storage houses, chill rooms, freezers or any other factory or place wherein the piping, machinery and other apparatus is under pressure, including boilers, tanks, jacketed kettles, generators, reservoirs and pipes used therein, and the apparatus connected therewith, and the extensions thereunto, wherein ammonia or other poisonous liquids, acids, gases, vapors or a combination thereof, poisonous or otherwise, are used in manufacturing houses, ice-making houses, packing houses, cold-storage houses, chill rooms, freezers, cooling plants, refrigerators or any other factory or place whatsoever owned or operated by any person, firm or corporation within the City of Detroit. Said inspections shall be made once a year in any event, and oftener whenever, in the judgment of the chief inspector, such inspection shall be necessary.

Sec. 2 (Drillings)—Any boiler, tank, jacketed kettle, generator or reservoir, and the pipes and extension thereof, and the apparatus connected therewith, in any manufacturing house, ice-making house, cooling plants, refrigerator, packing house, cold-storage house, chill room, freezer or any other factory or place whatsoever wherein the piping, machinery and


H=Generator
I=Ammonia Pump
J=Tubular Absorber
K=Anhydrous Receiver
L=Brine Cooler
M=Connect Emergency Discharge Pipes as shown
CONDENSER
RECEIVER
COMPRESSION SYSTEM
EXPANSION SYSTEM
Expansion Valve
Safety Valve
Check Valves (Optional)
Main Suction Stop Valve
Main Discharge Stop Valve
AMMONIA COMPRESSOR
Valve Box located at accessible Point
Check Valve
Std. Fire Dep't. 3" Siamese Connection
Globe Valves
Mixer with Outlet Conn. to Sewer
ABSORPTION SYSTEM
Install Safety Valve
RECTIFIER
Exhaust to Generator
Check Valve
Std. Fire Dep't. 3" Siamese Connection
Globe Valves
Check Valves (Optional)
Outlet to Sewer
Refrigerant Inlet
WATER & REFRIGERANT MIXER
Water Inlet
No. of 3/32" Holes-D
Plug
Outlet to Sewer
NOTE E
The outlet from the ejector shall be four times the area of "B" wherever possible. Where it is impossible to make the outlet four times the area of water inlet under standard conditions, a smaller-size apparatus shall be used, adjusted to the possible size of the outlet
NOTE X
For large plants use one additional mixer of maximum capacity for each additional 240 Tons or fraction thereof.
Plants containing more than one unit shall be independently connected to mixer or mixers from each main suction and discharge line

TONNAGE	SAFETY VALVE INLET	SAFETY VALVE OUTLET	DIAM. OF EACH EMERGENCY VALVE OR PIPE	INCHES A	B	C	D	No. of 3/32" HOLES	INCHES E	F	G
24	½"	1"	½"	1	1¼	5	266	SEE NOTE		50	15
56	¾	1¼	¾	1¼	2	6	460			60	20
102	1	1½	1	1½	2	7	625			70	25
166	1¼	2	1¼	2	2½	9	1000			90	30
240	1½	2½	1½	2	2½	9	1000			90	30
428	2	3	SEE NOTE X								

DRAWING A OF THE FIRE DEPARTMENT, NEW YORK CITY

apparatus is under pressure, having been used for five years or more, and its condition being such that in the opinion of the chief inspector and his assistants the same should be drilled, in order that the exact thickness and condition may be ascertained, and concerning which the said inspector or inspectors shall report the same to the chief inspector and said inspector shall forthwith serve, or cause to be served, the owner, agent, lessee or occupant, or person in possession or control thereof with a written notice to show cause to said chief inspector, within five days, why such boiler, tank, jacketed kettle, generator or reservoir, and the pipes and extensions and apparatus connected therewith, should not be drilled. If, after the said owner, agent, lessee or occupant has been heard at the end of five days, or upon his failure to appear within five days and show cause why such work hereinabove contemplated should not be done, the chief inspector deems it necessary that said boiler, tank, jacketed kettle, generator or reservoir, and the pipes and extensions and apparatus connected therewith, shall be drilled at such points as the inspecting officer may direct, and the drilling and plugging of said holes in said boilers, tanks, jacketed kettles, generators or reservoirs, and the pipes and extensions and apparatus connected therewithin, shall be done at the expense of the owner, agent, lessee or occupant.

INSPECTION OF PLANT BUILDING

Sec. 3 (Building, Etc., Reported Unsafe—Procedure)—It shall be the duty of the chief inspector, when it is reported to him that any part of any manufacturing house, ice-making house, cooling plant, refrigerator, packing house, cold-storage house, chill room, freezer or other factory or place wherein the boiler, tank, jacketed kettle, generator or reservoir and the pipes and extensions thereof and apparatus appertaining thereto are used under pressure, and wherein ammonia or other poisonous liquors, acids, gases, vapors or combination thereof, poisonous or otherwise, are used, is in an unsafe and dangerous condition, to make an examination of the same, and if they or any part of them are found to be in such an unsafe condition as to endanger life, he shall forthwith serve, or cause to be served, the owner, agent, lessee, occupant or person in possession, charge or control of said manufacturing house, ice-making house, cooling plant, refrigerator, packing house, cold-storage house, chill room, freezer or other factory or place, with a notice in writing to adopt such precautionary measures as shall have been specified by the Department of Safety Engineering that any part of any building wherein the apparatus covered by this ordinance is installed, is in such apparent unsafe condition as to raise a reasonable question as to the safety of the pipes or other apparatus installed therein, the Department of Safety Engineering shall thereupon inform the Building Department in writing of the condition of such buildings. It shall be the duty of the Building Department, upon this information in writing, to cause a joint inspection of the building or parts of buildings believed to be unsafe for the operation and use of apparatus covered by this ordinance.

Nothing in this ordinance shall be construed as authorizing the Department of Safety Engineering to issue permits for the construction or alteration of buildings.

Sec. 4 (Ice and Refrigerating Plants—Time of Inspection—When Not Required)—It shall be the duty of said chief inspector and his assistants to make the inspections of ice and refrigerating plants and parts thereof required by this article, so far as found practical, within the months of October, November and December, to the end that owners of plants shall be apprised of necessary repairs and renewals, and have sufficient time to make same before the approach of warm weather the following spring; but nothing in this section shall prevent the making of inspections during the other months as may be necessary for the protection of the public.

NO INSPECTION OF SUBMERGED COILS

It shall not be the duty of the chief inspector and his assistants, under the terms of this ordinance, to inspect any ammonia condenser or expansion or other coils, commonly used, submerged or covered in water or brine.

Sec. 5 (Plans and Specifications for New or Reconstructed Plants)—No new plants or any reconstruction of old plants for refrigeration or cooling purposes shall be installed or erected or maintained in the City of Detroit until the plans and specifications therefor have been filed in the office of the chief of the Department of Safety Engineering and approved by the chief inspector. Such plans shall show the amount of work to be done. Such plans and specifications shall also show that the room or apartment is provided with proper doors and proper means of exit, and air shafts, fans or other means of ventilation, to provide for the removal and escape of poisonous gas and a sufficient change of air to keep the rooms at a temperature not to exceed 90 deg. F.

Upon the approval of said plans, a duplicate set of which shall be left on file in the office of the Department of Safety Engineering, which office shall issue a permit for the installation of said plant.

It shall be the duty of the chief inspector to examine in detail all plans and specifications submitted to the department.

After the Department of Safety Engineering has approved the plans and specifications for the installation of apparatus covered by this ordinance with reference to the location of such apparatus, the character of the same, means for exit and other provisions covered by this ordinance, the building department shall then issue a permit for the construction or alteration of such buildings under the requirements of the building code, subject only to the requirements of this ordinance.

No alteration shall be made in buildings covered by this ordinance without permits from the Department of Safety Engineering and the Building Department, nor in apparatus without the approval of the Department of Safety Engineering.

Sec. 6 (Inspection Fees)—The fees for the inspection of cooling plants shall be as follows:

Class A—Including compressors or generators of over 50 tons' capacity, $5 each.

Class B—Including compressors or generators of less than 50 tons' capacity, $3 each.

All fees provided for in this ordinance shall be paid to the city treasurer.

Sec. 7 (Refrigerating Plants—Construction)—Each refrigerating plant shall be equipped with an emergency pipe or pipes by which, in case of accident, the gas under pressure can be discharged by a valve which can be opened inside and outside the refrigerating plant into water, or brought into contact with sufficient water to absorb and carry off all gases so discharged. At the discretion of the chief inspector the emergency pipe or pipes may conduct the gases to a point at least 10 ft. above the roofs of adjacent buildings into the open air.

Sec. 8 (Safety Devices)—All refrigerating machines shall be equipped with automatic safety devices which discharge at 300 lb. pressure to the square inch for ammonia, 1,400 lb. pressure to the square inch for carbon dioxide, 100 lb. pressure to the square inch for sulphur dioxide and 100 lb. pressure to the square inch for ethyl chloride into the emergency pipes required by the preceding section or into the low-pressure side.

GAS-FREE EXITS REQUIRED

Sec. 9. In refrigerating plants built and erected after the passage of this ordinance, every room containing pipes carrying a refrigerating chemical under pressure exceeding 40 lb. per sq.in. for ethyl chloride, 60 lb. for sulphur dioxide, 100 lb. for ammonia and 500 lb. for carbon dioxide, and which by accident may become filled with the gases generated by said chemicals, shall have an exit to the open air direct or by means of a stairway or to a room or hall from which said gases can be excluded. Other refrigerating plants shall be provided with such means of exit as the chief inspector may prescribe. Rooms which contain only the liquid supply pipe to the refrigerator coils are not included within the meaning of this section.

Sec. 10 (Pressure)—The maximum pressure allowed in refrigerating machines shall not exceed 300 lb. for ammonia, 1,400 lb. for carbon dioxide, 100 lb. for sulphur dioxide and 100 lb. for ethyl chloride to the square inch. All pipes used for refrigerating purposes shall stand a hydrostatic test of at least double the maximum pressure per square inch specified in this section. All fittings must be guaranteed to stand a pressure of at least three times the maximum pressure per square inch specified in this chapter.

Sec. 11 (Lights)—No room containing refrigerating condensers or compressors of ammonia or ethyl chloride under pressure shall have in it any open flame, arc light or direct opening into the boiler room; but an internal-combustion engine may be located therein, which may be started in the usual manner. There shall be a firewall between such room and the boiler room, equipped with a self-closing door.

Sec. 12 (Precautions—Helmets or Respirators)—In such large refrigerating plants as designated by the chief inspector there shall be kept, fit for available use, suitable helmets or respirators which shall permit the wearer to reach, without suffocation, any part of the refrigerating system.

Sec. 13 (Pipes to be designated)—In all refrigerating plants the pipes in the engine room shall have conspicuous signs displayed at proper places designating in easily legible letters the name of the refrigerating chemical contained therein.

Section 14 (Rules)—In all refrigerating plants there shall be posted several copies of a brief set of rules satisfactory

to the chief inspector, directing all employees as to their duties in case of fires or other emergencies. Employers shall be responsible for the proper drill of all employees in such emergency duties.

Sec. 15 (Supervision)—No refrigerating machines of over three tons' refrigerating capacity shall be operated unless under the charge of a person holding a certificate of fitness from the chief inspector.

Sec. 16 (Exemptions)—Surplus Storage.—Refrigerating plants may store a surplus stock of the refrigerating chemicals sufficient to recharge the system. Such charge must be stored in a cool place. No cylinders may be stored in a boiler room.

Sec. 17 (Refrigerating Machines of Less Than Three Tons' Capacity)—The chief inspector may exempt from the provisions of this article refrigerating machines of less than three tons' refrigerating capacity, provided a certificate of approval has been issued for such machine.

Sec. 18—When an inspection of any plant covered by this ordinance has been made and the operator, owner, lessee or agent of such plant has complied with the provisions of the ordinance, the chief inspector shall issue a certificate of inspection certifying under what conditions said plant may be operated under the authority of the City of Detroit. The certificate of inspection shall be properly framed and displayed under glass in a conspicuous place in the room where the apparatus upon which the certificate has been issued is being operated.

Sec. 19—Within 10 days after written notification by the chief boiler inspector to the owner or occupant to correct or remedy any hazardous condition, an appeal, stating specifically the questions which the appellant desires to have passed upon, may be taken. Such appeal shall be heard by the Board of Boiler Rules. The members of the board are authorized to take testimony and to grant or reject such an appeal, subject to review by the proper board.

Sec. 20 (Penalty)—Any person or corporation who violates, neglects or refuses to comply with, or who resists or opposes the enforcement of any of the provisions of this ordinance shall be fined not less than $100 nor more than $200 for each offense, and every such person or corporation shall be deemed guilty of a separate offense for every day on which said violation, neglect or refusal shall continue.

Sec. 21—All ordinances or parts thereof inconsistent herewith are hereby repealed.

Sec. 22—This ordinance shall take immediate effect.

Approved May 9, 1916.

Industrial Preparedness

The returns from the vast industrial inventory now being made throughout the Union by the Committee on Industrial Preparedness of the United States Naval Consulting Board mark a new and vital relation between the business men of America and the Federal Government. The information gathered is the first fruit of the work of the army of 30,000 American engineers, members of five national engineering societies, who form the field force of the committee organized to find out for the Government the real industrial resources of the nation in time of war.

For this sweeping canvass, which is headed by Howard E. Coffin, chairman, and W. S. Gifford, supervising director, the whole country has been highly systematized, with directing boards of the leading engineers in every state, the District of Columbia and Alaska. Many of the states have been split up into counties, with chief field aides in charge. This smooth-working organization of unpaid experts has already accomplished definite results, and the great inventory, as shown by the reports of state chairmen now being received, is moving swiftly and satisfactorily to its end.

The manufacturers have almost without exception responded with the most intelligent patriotism and the deepest interest in the movement. They were called upon to give very comprehensive information on the adaptability of their factories, mills and mines to Federal uses from the hour of military mobilization, the data to be held in the strictest confidence for the sole scrutiny and benefit of the War and Navy Departments of the United States.

A few manufacturers at first doubted the ability of their plants to aid the Government in war time, but they almost invariably changed their views when shown how little doubt there is that on the outbreak of war practically all concerns not engaged in lines of work essential to the national needs would be stripped of their labor, either for the army or for manning other industrial plants vital for the supply of such needs, and that in the event of hostilities probably 80 per cent. of the industries of America would of necessity be concentrated on producing the myriad elements of Twentieth Century warfare

Water Power Exhibit at "Tech"

Visitors to the recent dedication exercises of the Massachusetts Institute of Technology at Cambridge found an exhibit of surpassing interest assembled in one of the new buildings, under the title of "Water-Power Development." This display might well have been denoted "Peak Accomplishments in Hydro-Electric Practice," for instead of showing off a vast array of cut-and-dried facts about water powers, with repelling tables of machine sizes, speeds, pipe-line diameters, etc., it exhibited at a glance what its curator, Barrett Smith, appropriately called "the superlatives in hydro-electric accomplishment" to date. Photographs and large panoramic colored views of installations surpassing all others in some one or more particulars were installed on the walls, and the result was a most interesting bird's-eye view of the maximum achievements of the engineer in this important field, which still needs much development.

One plant's (Keokuk, Iowa) claim for consideration was the fact that it utilizes the largest low-head power to date. A pair of stations (Big Creek, Calif.) shown in panoramic view were famous as the homes of the largest-capacity tangential wheel so far installed, the magnitude of the output and height of head being unsurpassed when taken together. Another station uses the most powerful vertical turbines built, 20,000-hp. machines located on the St. Maurice River, Quebec, in the plant of the Laurentide Co., Ltd.; while a Western station, that of the Washington Water Power Co. at Long Lake, caps the climax of wheel rating with a 25,000-hp. maximum per unit.

Not only was the setting forth of these points a feature of the display, but the popular mind was given something to take home in the way of comparisons. Thus, the Big Creek development of the Pacific Power and Light Corporation, well known to engineers, was shown in a large panel drawing in colors, the drawing being divided into three horizontal zones and each zone representing an altitude range of 2,000 ft. At one side of the drawing was a sketch of the Woolworth, Metropolitan and Singer Buildings in New York, and attention was called to the striking fact that the 4,000-ft. combined head on the two plants exceeded twice the combined heights of these famous skyscrapers. As though this were not enough to hint at the magnitude of the development, the exhibitors cleverly arranged a $\frac{1}{16}$-in. pipe to discharge a stream of water into a funnel, the size of this stream being the measure of the flow of water required to deliver 1-hp. under the head in use at the Big Creek development. Finally, the interest of the technical man himself was whetted by showing him, through the courtesy of the manufacturer, a bucket of one of the big wheels of the kind installed, with the information that this single piece would yield 675 hp. under the station head.

Whenever it befalls the engineer or the plant manager to prepare an exhibit of his installation or development for popular instruction, such expedients as the foregoing should suggest the value of seeking the salient features of interest and of putting those up in a form that the visitor can appreciate. Even the technical engineer is not enthusiasm-proof when he runs into an exhibition of this kind, and he goes away from it with renewed inspiration as a worker in a profession where such notable things are accomplished.

ENGINEERING AFFAIRS

The Society for Electrical Development announces further progress in the plans for "Americas Electrical Week," to be held Dec. 2 to 9, with the object of promoting greater use of electricity for light, heat and power. Every city with a population of 20,000 or over will have a committee in charge of local arrangements, and over 1,200 representative electrical men have now been appointed to serve on these committees.

The American Institute of Steam Boiler Inspectors, Boston Division, held its seventh annual dinner at the Elks Home on Thursday evening, Apr. 27. Vice-President J. H. Gleason served admirably as toastmaster, and brief remarks were offered by Andrew J. Savage, the oldest U. S. Government inspector; John Gillespie, representing the New York branch; Fred R. Low, editor of "Power"; S. F. Jeter, chief engineer Hartford Steam Boiler Inspection and Insurance Co.; John A. Collins, Mutual Boiler Insurance Co.; W. J. Ranton, inspector Fidelity and Casualty Co., Rochester, N. Y.; Mr. Coysman, New England Boiler Works; James A. Kinkead, Parkesburg Iron Co.; William K. Campbell, Cambridge Iron Works; Joseph Cotter, dealer in boilers; P. H. Hogan, Dearborn Chemical Co.;

Harry Ashton, of the Ashton Valve company; Mr. Johnson, Babcock & Wilcox Co.; Robert Pirie, Crosby Steam Gage and Valve Co.; John Grundy, boiler specialist; John F. Molloy, chief inspector, Mutual Boiler Insurance Co.; Thomas G. Ranton, president of American Institute Steam Boiler Inspectors, Boston; Howard Tate, U. S. Government inspector; Daniel Smith, chief engineer, Amoskeag Manufacturing Co.; Adam Oldfield, treasurer American Institute Steam Boiler Inspectors, Boston.

OBITUARY

J. J. JENKINS

John J. Jenkins, Omaha's first boiler inspector and the builder of one of the first stationary engines used in Nebraska, died recently at Berkeley, Calif. Mr. Jenkins was 78 years old and was born in France. He was the father of Nebraska's free-school textbook law, and for six years was chief consul to San Salvador, appointed by President McKinley. Mr. Jenkins was the first labor commissioner for Nebraska. He is survived by a widow and two children.

GEORGE GILMOUR

George Gilmour, a prominent mechanical engineer, died May 15, 1916, at his home 107 Stratford Road, Brooklyn, N. Y., after a month's illness, in his fifty-second year. Mr. Gilmour was born in St. Petersburg, where his father was Naval Constructor to the Russian government. After receiving his education there and in England, he was sent by John Elder & Co., Glasgow shipbuilders, to South America. On his return he was engaged by the French engineers to take charge of the mechanical department of the work being done on the Panama Canal by the French company. Later he became connected with the Atlas Line of steamships and with the Jamaica Government Railway. After eight years in Jamaica Mr. Gilmour came to New York City and became mechanical engineer for the New York Telephone Co., from which he resigned after eight years to become chief engineer of the Travelers Insurance Co. He was an authority on accident prevention and industrial safety, and in 1910 was sent to Europe as a member of the commission of the State of New York on Employers' Liability, Causes and Prevention of Industrial Accidents, to investigate European methods. He was a charter member and trustee of the American Museum of Safety and a member of the following technical societies: American Society of Mechanical Engineers, American Railway Master Mechanics' Association, International Boiler Makers' Association, American Society for Testing Materials, International Society for Testing Materials and the Engineers Club of New York.

MISCELLANEOUS NEWS

Boiler Explosion at Brewton, Ala.—The large boiler at the plant of the T. R. Miller Mill Co. exploded on the night of June 3, instantly killing two men, fatally injuring two others and wrecking the engine room.

Locomotive Tube Burst at West Point, Miss.—On June 4 a bursting tube in a Mobile & Ohio engine flooded the cab with hot water and steam, scalding the fireman and a flagman, the engineer escaping out the cab window. The engine was put out of commission entirely, all steam and water escaping.

Manufacturing Plant to be Auctioned—The plant of the Shirley Radiator and Foundry Co., Indianapolis, Ind., will be sold at auction June 29. It includes a large machine shop and foundry, both stocked and equipped ready for operation, and would be suitable not only for radiator manufacture, but for any foundry work, boiler making or the manufacture of any metal products, auto accessories, auto parts or war munitions.

Damage from Bursting Steam Pipe—A steam pipe in the basement of the John C. Lewis Co., operating a department store at Louisville, Ky., exploded on June 5, doing some damage in the immediate vicinity and more through drenching of fabrics and garments with the vapor which rose to the upper floors. Service by the elevators (hydraulic) and the lighting plant was interrupted until repairs were made.

Memphis to have Municipal Plant—F. W. Ballard, the representative of the City of Memphis, Tenn., in the appraisal of the Merchants Power Company's plant, has reported to the Board of Commissioners that efforts to select a third arbitrator have proven unavailing, and he has recommended that the city proceed with the construction of a plant, as provided by the terms of a recent $1,500,000 bond issue. He reported that the city could sell current at 5c. per kw.-hr. and that it is probable that production cost will be 3c. The State Supreme Court recently handed down a decision sustaining the validity of these bonds, which were contested on various technical grounds.

Power from Steam Generated at Garbage Crematory—R. C. Turner, city electrician of Atlanta, Ga., has prepared a statement urging the utilization at the garbage creamatory of the steam at present being wasted, provided the plant is taken over by the city. He states that the city can get sufficient steam to generate 1,500 kw. continuously if enough garbage is supplied, and that something like $2,000 per month is paid for electric current at the pumping station alone, all of which and more could be saved by the plan outlined. "It is essential that the city get busy in some way to stop this waste of steam going on at the crematory. About $100,000 worth has been wasted since the city and the company have been litigating."

PERSONALS

William A. Armes, industrial and power-plant engineer, is now with the Samuel M. Green Co., Springfield, Mass.

Lewis L. McLaren, heretofore steam engineer with the Wisconsin Steel Co., South Chicago, Ill., is now with the Illinois Steel Co., Gary, Ind.

Martin H. Ray has gone with the Crocker-Wheeler Co., Ampere, N. J., resigning his connection with the Department of Public Safety of Philadelphia, Penn.

John H. McNally has been made Philadelphia manager of the Huber Hand Stoker Co., Inc., of New York. He was formerly in the employ of the city of Philadelphia.

E. W. Patton, master mechanic of the Follansbee Bros., Co., Follansbee, W. Va., has gone into business for himself, having purchased the Lisbon Pure Milk Co., of Lisbon, Ohio.

Axel E. Berggren has resigned as mechanical engineer of the Faultless Rubber Co., Ashland, Ohio, to join the sales force of the American Blower Co., of Detroit, Mich.

C. R. McGahey, formerly superintendent for the Covington Machine Co., Covington, Ky., is now sales engineer for the Nelson Valve Co., Philadelphia, Penn., traveling in the Southern States.

C. J. Moulton has been appointed New York sales manager for the Sims Co., Erie, Penn., designers and manufacturers of steam specialties, succeeding his brother, the late P. A. Moulton.

Earle B. Norris, until recently associate professor of mechanical engineering at the University of Wisconsin, has been appointed industrial commissioner of the Association of Commerce, St. Paul, Minn.

Charles W. Tubby, who was district manager of the International Steam Pump Co. at St. Paul, Minn., becomes St. Paul sales manager of the company under its reorganized style of Worthington Pump and Machinery Corporation.

William J. Kenney, for eight years chief engineer for the Underfeed Stoker Co. of America, has become president of the Moloch Stoker Co., Continental & Commercial National Bank Building, Chicago, manufacturers of the Moloch automatic self-cleaned underfeed stoker.

Herbert C. Hale, formerly district manager of the Ridgway Dynamo and Engine Co., at Cleveland, Ohio, has incorporated the Hale-Stephan Co. in that city to represent the Taylor Stoker Co., the Ridgway Dynamo and Engine Co., the Vulcan Soot Cleaner Co. and the Engineer Co.

Fred D. Knight, who has been superintending the construction of several power stations in Texas for the Stone & Webster Engineering Corporation, Boston, Mass., during the past seven years, is at present in charge of the installation of a 35,000-kw. turbine and the erecting of an extension to the building to accommodate it at the South Boston power station of the Boston Elevated Railway Co.

Robert A. Carleton, for many years inspector of construction with the Edison Electric Illuminating Co., of Boston, and Albert E. Mace have resigned their positions with that company and have organized a construction company to be known as the Carleton-Mace Engineering Corporation. It will specialize in central-station and industrial power-plant installation and electric transmission systems, with headquarters in Boston.

Classified Ads

Positions Wanted
Positions Open
Civil Service Work
Employment Agencies
Labor Bureaus
Business Opportunities
For Sale
Wanted
Agents and Salesmen
Contract Work
Miscellaneous
Educational
Books
Proposals

RATES: Positions Wanted, 3 cents a word, minimum charge 50 cents an insertion, payable in advance. Other advertisements, 5 cents a word, minimum charge $1.00. Count 4 words for blind address care of our New York or Chicago offices. Advertisements for bids $3.60 an inch.

ANSWERS addressed to us at 10th Ave. and 36th St., New York or 1144 Monadnock Block, Chicago will be forwarded without charge (excepting circulars or similar literature).

IMPORTANT: Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents—send copies. Advertisers' names will not be furnished under any circumstances. Copy received until 10 A.M. Tuesday for following Tuesday's issue. P

POSITIONS OPEN

California

INSTRUCTOR; technical college in California needs graduate in mechanical engineering. Assist in steam, hydraulic, testing laboratories. Possibly teach applied mechanics. Salary about $1,000. P840—Power, Chicago.

New Jersey

ASSISTANT TO PLANT ENGINEER wanted, in Eastern factory a young mechanical engineer of several years practical experience. Should be fair draftsman with some working knowledge of machine design. Excellent prospects for advancement. P838—Power.

New York

STEAM ENGINEERS wanted, with turbine experience. Also substation operators. State age, experience and salary expected. P841—Power.

Civil-Service Opportunities

Competitive examinations for the civil-service positions named below will be held on or up to the dates given. For detailed information, write the addresses specified.

ASSISTANT ENGINEER (power plant supervision), Grade E, $2,280-$3,180; applications received until 4 p.m., June 30; for vacancy in Department of Public Charities; open to residents of State of New York only. Write to Municipal Civil Service Commission, Municipal Bldg., New York, N. Y., for Application Form C.

Employment Agencies

CORRESPONDENT

THE UNDERSIGNED plans and conducts correspondence for positions in technical, manufacturing and professional lines; $2500 to $15,000 men exclusively; complete privacy assured; no commission charged—only service fee and postage. Send name and address only, in confidence, for prefatory details. R. W. Bixby (established 1910), P1 Niagara Square, Buffalo, N. Y.

POSITIONS WANTED

Texas

ELECTRICAL, STEAM AND DIESEL ENGINEER wants position; temperate, married; part technical education; five years' experience and good mechanic; very best references. PW842—Power, Chicago.

Virginia

YOUNG MECHANICAL ENGINEERING GRADUATE desires a position affording engineering experience; can furnish good references. Available immediately. Box 180, Amherst, Va.

Wisconsin

MANUFACTURERS, ATTENTION: Have you an opening for a young man of good appearance and address; married, who is now, and has been for more than five years, western sales manager for one of the largest and best known manufacturers of injectors and steam specialties? Enjoy wide acquaintance among jobbers of engineers, mill and plumbing supplies. Could market meritorious specialty. Unquestionable references as to ability, reliability, etc. PW839—Power, Chicago.

WANTED

AGENTS AND SALESMEN

REPRESENTATIVES selling steam specialties to sell high-grade traps, blowoff valves, etc., on liberal commissions. W824—Power.

AGENTS handling engine and boiler room specialties, in every section, for side line, paying large commissions. Give experience, lines carried and territory covered. W390—Power.

SALES ENGINEER, stokers and boilers, desires new connection with large concern needing such services in Eastern territory; has large acquaintance and knowledge in stoker lines. W831—Power.

SALESMAN wanted having experience and acquaintance to represent a large belting manufacturer. W832—Power.

BUSINESS MAN, located in Philadelphia, organizing a selling company, wishes to get in touch with manufacturers of Mechanical Appliances; has had wide experience in the manufacturing end of mechanical trades; also selling to the large consumers throughout the Eastern States. W823—Power.

AGENTS on commission to sell our Shaking Grates; we will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

MISCELLANEOUS

PATENT ATTORNEYS

PATENTS. C. L. Parker, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventor's handbook sent upon request.

IS YOUR INVENTION VALUABLE? Ask A. P. Connor, electrical, mechanical engineer (ex-chief electrical engineer for New York). Patent attorney. Lawyer. Carroll St., S. E., Washington, D. C.

For Sale

Second Hand Equipment

Rates: Less than 4 insertions 75 cents per line—4 to 11 insertions 70 cents per line—12 or more insertions 65 cents per line

Equipment Wanted items appear at the end of this list.

ADVERTISERS' NAMES are abbreviated in most of these items. Complete names and addresses are as follows: POWER Mchy. Exchange, 14 Morris St., Jersey City, N. J.

BOILERS

2—150-H.P. Ames H.R.T., 125 lb. pressure; 50-H.P. Ames locomotive on wheels; 30-H.P. Ames-Empire type; 20-H.P. Erie combined locomotive boiler and engine on skids.—L. F. Seyfert's Sons, Inc., 437 N. Third St., Phila., Pa.

(Water tube.) (Insurance certificate 150-lb. pressure)—
Ten 250-hp. Babcock & Wilcox, $11,250;
One 425-hp. Babcock & Wilcox, $1,900;
Two 350-hp. Heine, $3,000;
Three 300-hp. Babcock & Wilcox, $4,000;
One 200-hp. Heine, $800.—POWER MCHY.

2—150-hp. return tubular and 2—150-hp. Manning, in excellent condition, in New York vicinity.—F. W. Fox, 1220 Whitehall Bldg., New York City.

ENGINES, GAS

Westinghouse vertical, 40 hp., now running; in best possible condition. Selling because of purchase of a larger unit. Delivery immediately.—The Acklin Stamping Co., Toledo, O.

65-kw. 125-volt Fairbanks generator direct connected Fairbanks gas engine, $1,000; 50-kw. 230-volt Fairbanks generator direct connected Fairbanks gas engine, with producer, $1,000.—POWER MCHY.

ENGINES, OIL

180-hp. De La Vergne type "HF," $6,500.—POWER MCHY.

25-hp. Meitz & Weiss fuel engine and accessories; used five years; price $600.—Attleboro Refining Co., Attleboro, Mass.

A 3-cylinder 120-hp. Busch-Sulzer Bros. Diesel engine in perfect condition for use; critical inspection invited; no brokers.—Atlantic Light & Power Co., Coeymans, N. Y.

ENGINES, STEAM

1 Hamilton Corliss, 22x48, A1 condition.—The Vinton Co., Detroit, Mich.

16x36 Fishkill Corliss, like new, $475.—POWER MCHY.

Hamilton Corliss girder frame single eccentric 18x42 engine with flywheel 25" face, 14" diameter.—PILLSBURY FLOUR MILLS CO., Minneapolis, Minn.

1—80-hp. at 225 r.p.m. Brownell Co. steam engine with 11"x18" cyl. S.M. right shaft governor, 6'x14½" drive pulley, in good running order; price right. Address The Lennox Chemical Co., 1201 East 55th St., Cleveland, Ohio.

GENERATING UNITS

50-kw. American Ball 230-volt generator direct connected American Ball duplex engine, $800.—POWER MCHY.

37½ kw., 125-volt D.C. Ames engine, price $600.—706 Old South Bldg., Boston, Mass.

GENERATORS

Complete "Stock" of direct and alternating current generators and motors.—POWER MCHY.

2—1,200-kw., 25-cycle, 6,600-volt, 3-phase General Electric alternators with 30"x50"x60" Allis Corliss horizontal cross-compound engines; 1—800-kw., 600-volt, direct current generator with 32"x60" simple Allis Corliss engine.—UNITED RAILWAYS CO., 3869 Park Ave., St. Louis, Mo.

PUMPS

Four second-hand Vertical Dry Vacuum Pumps, piston type, duplex and double acting, built by the Deane Steam Pump Company, of Holyoke, Mass. Cylinders of acid bronze, diameter 20 in., stroke 18 in. Each with cut cast iron spur gear and cut steel pinion, steel pinion shaft, ring oiling bearings, Moore & White cut-off coupling and belt pulley. In good running condition. On account of change in method machines not needed. Will make an attractive price.—Hammermill Paper Co., Erie, Pa.

TRAVELING CRANES

One 40-ft. span, 15-ton electric traveling crane D.C. 220-volt, hoist 12-hp., trolley 7-hp., bridge 10-hp. This crane has just been removed to make way for a new one. Hoisting motor should be renewed. MURRAY IRON WORKS CO., Burlington, Iowa.

[Additional For Sale ads. on page 42.]